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OUTAGE PERFORMANCE OF DUAL DIVERSITY RECEIVER OVER RACIAN FADING CHANNEL

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ABSTRACT

In wireless communication fading is a phenomenon which degrades the performance of the link which includes Rayleigh, weibull, Nakagami-q, Nakagami-m, Rician fading. In this paper the outage performance of dual diversity receiver overRician fading channel have been analysed. For this purpose probability density function(PDF) of SNR, cumulative distribution function (CDF) and outage performance (P_{out}) using different diversity combining techniques selection combining, maximal ratio combining, equal gain combining and switch & stay combining for dual receiver is analysed for different value of Rice factor K.

Keywords: Diversity Combining Techniques, Dual Diversity, Outage Probability, Probability Distribution Function,Rician fading channel.

I INTRODUCTION

In wireless communication fading is a phenomenon which degrades the performance of the link it includes Rayleigh, weibull, Nakagami-q, Nakagami-m, Rician fading.The Rician fading distribution is often used to model propagation paths, consisting of one strong direct line-of-sight (LoS) signal and many randomly reflected and usually weaker signals. Independent fading path can be achieved by using multiple transmit or receive antenna array, where the elements of array are separated in distance. This type of diversity is called space diversity [1].Space diversity receptionis a very efficient technique for mitigating fading and co-channel interference (CCI) effects to improve the quality of service (QoS) in wireless communication systems. Variousdiversity combining techniques are used for reducing the fading effects and the influence of the co-channel interference (CCI) in wireless communication systems for which all the calculations are evaluated [2]. In this paper mainly four types of combining techniques selection combining (SC),maximal ratio combining (MRC), equal gain combining (EGC) and switch and stay combining (SSC) have been analysedin respect to their PDF of SNR as well as cumulative distribution function (CDF) or outage probability (P_{out})[3],[4],[5]. Outage performance of dual diversity under Rayleigh fading channels have been studied in [6]. Performance of dual diversity under a-μfading channels has been studied in [7]. Performance selection combining receivers been studied in [8]. Performance of switch and stay combining receivers have been studied in [9],[11]. Performances of EGC and MRC have been studied in [10].

The rest of the paper is organised as follows. In section 2, Rician fading model is briefly discussed. In section 3, diversity combining techniques for Rician fading channel is discussed. In section 4,the simulation result has been analysed, and section 5, concludes the paper.

II RICIAN FADING MODEL

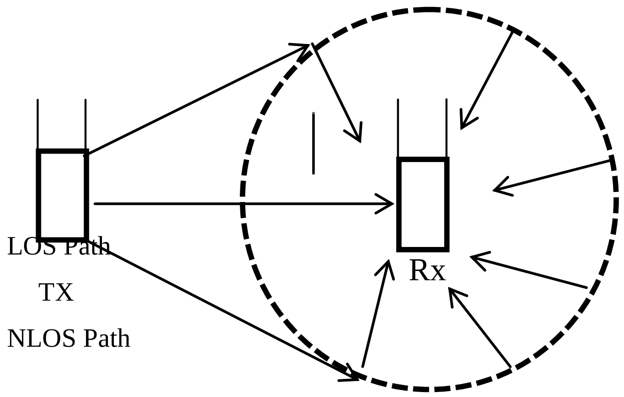

Fig 1.Rician fading model

2.1 Rician Fading

Some types of scattering environment have specular or LOS components. If $g_I(t)$ and $g_Q(t)$ are Gaussian random process with non-zero mean $m_I(t)$ and $m_Q(t)$. If we again assume that these process are uncorrelated and random variable $g_I(t)$ and $g_Q(t)$ have the same variance σ^2. Then magnitude of the received complex envelop at time t has a Rician distribution as [3, Eq. (2.45)]

$$f_{\alpha_l}(x) = \frac{x}{\sigma^2} e^{-\frac{(x^2+s^2)}{2\sigma^2}} I_0\left(\frac{xs}{\sigma^2}\right) \quad (1)$$

Where

l=1, 2

$$s^2 = m^2{}_I(t) + m^2{}_Q(t) \quad (2)$$

is called the non-centrality parameter. This type of fading is called Ricean fadingand is very often observed in microcellular and mobile satellite applications. A very simple Ricean fading model assumes that the means $m_I(t)$ and $m_Q(t)$ are constants, i.e. $m_I(t) = m_I$, and $m_Q(t) = m_Q$.The means $m_I(t)$ and $m_Q(t)$corresponding tothe in phase and quadrature components of the LoS signal are given by

$$m_I(t) = s.\ cos(2\pi f_m cos\theta_0 t + \phi_0) \quad (3)$$

$$m_Q(t) = s.\ sin(2\pi f_m sin\theta_0 t + \phi_0) \quad (4)$$

Where$f_m cos\theta_0$and$\phi_0$are the Doppler shift and random phase off set associatedwith the LoS or specular component, respectively.

The Rice factor**,** K, is defined as the ratio of the specular powers^2 toscattered power $2\sigma^2$i.e.K= $s^2/2\sigma^2$, When K= 0 the channel exhibitsRayleigh fading, and whenK=∞ the channel does not exhibit any fading atall. The envelope distribution can be rewritten in terms of the Rice factor andthe average envelope powerE$[\alpha^2] = \Omega_p = s^2/2\sigma^2$by first noting that

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$$s^2 = \frac{K\Omega_p}{K+1},\ 2\sigma^2 = \frac{\Omega p}{K+1} \quad (5)$$

It then follows

$$f_{\alpha_l}(x) = \frac{x}{\sigma^2} = \frac{2x(K+1)}{\Omega_p} exp\left\{-K - \frac{(K+1)x^2}{\Omega_p}\right\} I_0\left(2x\sqrt{\frac{K(K+1)}{\Omega_p}}\right),\ x>=0 \quad (6)$$

Where

Ω_p is total received envelop power

Ω_p = E[g_I^2(t)] +E[g_Q^2(t)] =$\sum_{n=1}^{N} c_n^2$

c_n is the magnitude associated with n preoperational path

α = received complex envelop which is Rician distributed

α = N(m_I, σ^2) + j*N(m_Q, σ^2)

N = (. , .) Normally or Gaussian distributed random variable

x= running variable

σ^2 = Variance

s = $\sqrt{m_I^2 + m_Q^2}$

m_I= mean of in phase component

m_Q=mean of quadrature phase components

I_0 = zero order modified Bessel function of the first kind

j = complex operator

III DIVERSITY COMBINING TECHNIQUE

Diversity technique provides multiple copies of the same signal on different branches, which undergo independent fading. If one branch undergoes a deep fade, another branch may have strong signal. In space diversity fading is minimized by the simultaneous use of two or more physically separated antennas. Thus having more than one path to select the SNR at receiver may be improved by selecting appropriate combining technique. SNR γ is a random variable and is given for different diversity schemes.

$\gamma \in \{ \gamma_{SC}, \gamma_{MRC}, \gamma_{EGC}, \gamma_{SSC} \}$

Following diversity combining techniques for Rician fading channels are discussed.

3.1 Selection Combining (SC)

Selection combining is based on the principle of selecting the best signal among all the signals received from different branches at the receiving end. In this method, the receiver monitors the SNR of the incoming signal using switch logic. The branch with highest instantaneous SNR is connected to demodulator. SNR of selection combining is given as

γ_{SC}= Max (R_1^2, R_2^2)

Where R1 and R2 represent the fading envelope for two channels seen by two different antennas.

CDF of selection combining with two receive antennas can be calculated from [12, Eq.(11)]

$$F_{\gamma_{SC}}(\gamma) = \left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2 \left[\sum_{k=0}^{\infty} \left(\frac{s^k}{k!\,\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(\boldsymbol{k+1},\ \frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{k+1}}}\right]^{\mathbf{2}} \quad (7)$$

The above equation can be evaluated from [2, Eq. (8.352)]

$$F_{\gamma_{SC}}(\gamma) = \left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2 \left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{k!\left[1-e^{-\frac{\gamma}{\bar{\gamma}}}\left(\sum_{m=0}^{k}\frac{\left(\frac{\gamma}{\bar{\gamma}}\right)^m}{m!}\right)\right]}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right]^2 \quad (8)$$

PDF of SC is $f_{\gamma_{SC}}(\gamma)=\frac{dF_{\gamma_{SC}}(\gamma)}{d\gamma}$

$$f_{\gamma_{SC}}(\gamma) = \frac{d}{d\gamma}\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2 \left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{k!\left[1-e^{-\frac{\gamma}{\bar{\gamma}}}\left(\sum_{m=0}^{k}\frac{\left(\frac{\gamma}{\bar{\gamma}}\right)^m}{m!}\right)\right]}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right]^2$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\frac{d}{d\gamma}\left[1-e^{-\frac{\gamma}{\bar{\gamma}}}\left(\sum_{m=0}^{k}\frac{\left(\frac{\gamma}{\bar{\gamma}}\right)^m}{m!}\right)\right]^2\right]$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\,2\left[1-e^{-\frac{\gamma}{\bar{\gamma}}}\left(\sum_{m=0}^{k}\frac{\left(\frac{\gamma}{\bar{\gamma}}\right)^m}{m!}\right)\right]\right]$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\,2\left[1-\left[\sum_{m=0}^{k}\frac{(\bar{\gamma})^{-m}}{m!}\,e^{-\frac{1}{\bar{\gamma}}}\frac{d}{d\gamma}(e^{-\gamma}\gamma^m)\right]\right]\right]$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\,2\left[1-\left[\sum_{m=0}^{k}\frac{(\bar{\gamma})^{-m}}{m!}\,e^{-\frac{1}{\bar{\gamma}}}[\mathrm{m}\,e^{-\gamma}\gamma^{m-1}-\gamma^m e^{-\gamma}]\right]\right]\right]$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\,2\left[1-\left[\sum_{m=0}^{k}\frac{(\bar{\gamma})^{-m}}{m!}\,e^{-\frac{1}{\bar{\gamma}}}e^{-\gamma}\gamma^{m-1}(m-\gamma)\right]\right]\right]$$

$$f_{\gamma_{SC}}(\gamma)=\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^4 \frac{(k!)^2}{\left(\frac{1}{\bar{\gamma}}\right)^{(k+1)^2}}\left[2(1-e^{-\frac{\gamma}{\bar{\gamma}}}\left[\sum_{m=0}^{k}\frac{\left(\frac{\gamma}{\bar{\gamma}}\right)^m}{m!}\left[\sum_{m=0}^{k}\frac{(\bar{\gamma})^{-m}}{m!}\,e^{-\frac{1}{\bar{\gamma}}}e^{-\gamma}\gamma^{m-1}(m-\gamma)\right]\right]\right]\right] \quad (9)$$

3.2 Maximal Ratio Combining (MRC)

This is the most complex scheme in which all branches are optimally combined at the receiver. MRC requires scaling and co-phasing of individual branch. In this all the signals are weighted according to their individual signal voltage to noise power ratios and then summed. Thus MRC produces an output SNR, which is equal to the sum of the individual SNRs. Best statistical reduction of fading is achieved by this method. SNR of MRC is calculated using convolutional properties.

Convolution Properties

The convolution of f_γ (γ) and f_γ (γ) is written f_γ (γ) ⊕ f_γ (γ), using convolutional operator ⊕. It is defined as the integral of the product of the two functions after one is reversed and shifted. As such, it is a particular kind of integral transform:

$f_{\gamma_{MRC}}(\gamma) = f_\gamma(\gamma) \oplus f_\gamma(\gamma)$

$f_{\gamma_{MRC}}(\gamma)=\int_{-\infty}^{\infty} f_\gamma(\tau)\, f_\gamma(\gamma-\tau)d\tau$

For functions $(f_\gamma(\gamma), f_\gamma(\gamma))$ supported on only $0 \rightarrow \infty$ (i.e., zero for negative arguments), the integration limits can be truncated, resulting in

$f_{\gamma_{MRC}}(\gamma)= \int_0^\gamma f_\gamma(\tau)\, f_\gamma(\gamma-\tau)\, d\tau$

PDF of MRC is $f_{\gamma_{MRC}}(\gamma) = \int_0^\gamma f_\gamma(\tau)\, f_\gamma(\gamma-\tau)\, d\tau$

$$f_\gamma(\tau) = \left(\frac{1}{\bar{\gamma}}\right) e^{-\frac{(\tau+s^2)}{\bar{\gamma}}} \sum_{j=0}^{\infty} \frac{1}{\Gamma(j+1)j!}\left(\frac{\sqrt{\tau}s}{\bar{\gamma}}\right)^{2j} \quad (10)$$

$$f_\gamma(\gamma-\tau) = \left(\frac{1}{\bar{\gamma}}\right) e^{-\frac{(\gamma-\tau+s^2)}{\bar{\gamma}}} \sum_{k=0}^{\infty} \frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma-\tau}\, s}{\bar{\gamma}}\right)^{2k} \quad (11)$$

PDF of MRC can be calculated using Eq. (10)&(11)

$f_{\gamma_{MRC}}(\gamma)=\int_0^\gamma f_\gamma(\tau)\, f_\gamma(\gamma-\tau)\, d\tau$

$$f_{\gamma_{MRC}}(\gamma)=\int_0^\gamma \left[\frac{1}{\bar{\gamma}}\, e^{-\frac{(\tau+s^2)}{\bar{\gamma}}} \sum_{j=0}^{\infty} \frac{1}{\Gamma(j+1)j!}\left(\frac{\sqrt{\tau}s}{\bar{\gamma}}\right)^{2j}\right]\left[\frac{1}{\bar{\gamma}}\, e^{-\frac{(\gamma-\tau+s^2)}{\bar{\gamma}}} \sum_{k=0}^{\infty} \frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma-\tau}s}{\bar{\gamma}}\right)^{2k}\right]d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\int_0^\gamma \left[\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{\sqrt{\tau}s}{\bar{\gamma}}\right)^{2j} \left(\frac{\sqrt{\gamma-\tau}s}{\bar{\gamma}}\right)^{2k}\right]d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \int_0^\gamma \left(\frac{\sqrt{\tau}s}{\bar{\gamma}}\right)^{2j} \left(\frac{\sqrt{\gamma-\tau}s}{\bar{\gamma}}\right)^{2k} d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \int_0^\gamma \left(\frac{\tau s^2}{\bar{\gamma}^2}\right)^{j} \left(\frac{(\gamma-\tau)s^2}{\bar{\gamma}^2}\right)^{k} d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \int_0^\gamma (\tau)^j\, (\gamma-\tau)^k d\tau$$

The above equation can be calculated from [2, Eq.1.111]

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \int_0^\gamma (\tau)^j \sum_{i=0}^{n}\binom{n}{i}(-\tau)^i(\gamma)^{n-i}d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n}\binom{n}{i}(-1)^i(\gamma)^{n-i}\int_0^\gamma (\tau)^j\,(\tau)^i\, d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n}\binom{n}{i}(-1)^i(\gamma)^{n-i}\int_0^\gamma (\tau)^{i+j} d\tau$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n}\binom{n}{i}(-1)^i(\gamma)^{n-i}\frac{\gamma^{i+j+1}}{i+j+1}$$

$$f_{\gamma_{MRC}}(\gamma)=\frac{1}{\bar{\gamma}}\, e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty}\sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right) \left(\frac{s}{\bar{\gamma}}\right)^{2j}\left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n}\binom{n}{i}(-1)^i\frac{\gamma^{n+j+1}}{i+j+1} \quad (12)$$

Outage Probability P_{out}

$P_{out\ MRC} = F_{\gamma MRC}(u) = \int_0^u f_{\gamma MRC}(\gamma)d\gamma$

$F_{\gamma_{MRC}}$ (u) $=\int_0^u \frac{1}{\bar{\gamma}}\ e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right)\ \left(\frac{s}{\bar{\gamma}}\right)^{2j} \left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n} \binom{n}{i} (-1)^i \frac{\gamma^{n+j+1}}{i+j+1}\ d\gamma$

$F_{\gamma_{MRC}}$ (u) $=\frac{1}{\bar{\gamma}}\ e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right)\ \left(\frac{s}{\bar{\gamma}}\right)^{2j} \left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n} \binom{n}{i} (-1)^i \int_0^u \frac{\gamma^{n+j+1}}{i+j+1}\ d\gamma$

$F_{\gamma_{MRC}}$ (u) $=\frac{1}{\bar{\gamma}}\ e^{-(\gamma+2s^2)} \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} \left(\frac{1}{\Gamma(j+1)j!}\right)\left(\frac{1}{\Gamma(k+1)k!}\right)\ \left(\frac{s}{\bar{\gamma}}\right)^{2j} \left(\frac{s}{\bar{\gamma}}\right)^{2k} \sum_{i=0}^{n} \binom{n}{i} (-1)^i \frac{u^{n+j+2}}{(n+j+2)(i+j+1)}$ (13)

Whereγ is instantaneous SNR and$\bar{\gamma}$is averageSNR

$\gamma = |\alpha|^2$

k,i = running variable

3.3Equal Gain Combining (EGC)

A variant of MRC is equal gain combining (EGC), where signals from each branch are co-phased and their weights have equal magnitude. This method also has possibility like MRC of producing an acceptable output signal from a number of unacceptable input signals. SNR improvement of EGC is better than selection combining but not better than MRC. SNR of EGC is given as

$\gamma_{EGC} = \frac{(\alpha_1+\alpha_2)^2}{2}$

$\gamma_{EGC} = \frac{\alpha^2}{2}$

Here $\alpha = \alpha_1 + \alpha_2$

$f_\alpha(\alpha) = \int_0^\alpha f_{\alpha 1}(\tau)\ f_{\alpha 2}(\alpha-\tau) d\tau$

Probability density function of envelop

$f_\alpha(x) = \frac{x}{\sigma^2} e^{-\frac{(x^2+s^2)}{2\sigma^2}} I_0(\frac{xs}{\sigma^2})$ x>=0, (14)

Where

$I_0(.)$is zero order modified Bessel function of the first kind

$I_0(\frac{xs}{\sigma^2}) = \sum_{k=0}^{\infty} \frac{1}{\Gamma(k+1)k!} (\frac{xs}{2\sigma^2})^{2k}$ is evaluated from [2, Eq. (8.445)]

By putting the value of $I_0(.)$ in Eq. 14 we get

$f_\alpha(x) = \frac{x}{\sigma^2} e^{-\frac{(x^2+s^2)}{2\sigma^2}} \sum_{k=0}^{\infty} \frac{1}{\Gamma(k+1)k!} (\frac{xs}{2\sigma^2})^{2k}$ (15)

$f_{\alpha_1}(\tau) = \frac{\tau}{\sigma^2} e^{-\frac{(\tau^2+s^2)}{2\sigma^2}} \sum_{k=0}^{\infty} \frac{1}{\Gamma(k+1)k!} \left(\frac{\tau s}{2\sigma^2}\right)^{2k}$ (16)

$f_{\alpha_2}(\alpha-\tau) = \frac{(\alpha-\tau)}{\sigma^2} e^{-\left(\frac{(\alpha-\tau)^2+s^2}{2\sigma^2}\right)} \sum_{j=0}^{\infty} \frac{1}{\Gamma(j+1)j!} \left(\frac{(\alpha-\tau)s}{2\sigma^2}\right)^{2j}$ (17)

Where α_1 is fading envelop seen by antenna 1&α_2 is fading envelop seen by antenna 2

Using Eq. 16 and 17 we calculate the PDF of envelop for EGC

$f_\alpha(\alpha) = \int_0^\alpha f_{\alpha 1}(\tau)\ f_{\alpha 2}(\alpha-\tau) d\tau$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}\frac{\tau}{\sigma^2}e^{-\frac{(\tau^2+s^2)}{2\sigma^2}}\sum_{k=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}\frac{(\alpha-\tau)}{\sigma^2}e^{-\left(\frac{(\alpha-\tau)^2+s^2}{2\sigma^2}\right)}\sum_{j=0}^{\infty}\frac{1}{\Gamma(j+1)j!}\left(\frac{(\alpha-\tau)s}{2\sigma^2}\right)^{2j}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}\frac{(\alpha\tau-\tau^2)}{\sigma^4}e^{-\left(\frac{\tau^2+s^2+(\alpha-\tau)^2+s^2}{2\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}\frac{1}{\Gamma(j+1)j!}\left(\frac{(\alpha-\tau)s}{2\sigma^2}\right)^{2j}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}\frac{(\alpha\tau-\tau^2)}{\sigma^4}e^{-\left(\frac{2\tau^2+2s^2+\alpha^2-2\alpha\tau}{2\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}\frac{1}{\Gamma(j+1)j!}\left(\frac{\alpha s-\tau s}{2\sigma^2}\right)^{2j}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}\frac{(\alpha\tau-\tau^2)}{\sigma^4}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}e^{-\left(\frac{\tau^2}{\sigma^2}\right)}e^{-\left(\frac{\alpha\tau}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}\frac{1}{\Gamma(j+1)j!}\left(\frac{\alpha s-\tau s}{2\sigma^2}\right)^{2j}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}\frac{(\alpha\tau-\tau^2)}{\sigma^4}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{e^{-\left(\frac{\tau^2}{\sigma^2}\right)}e^{-\left(\frac{\alpha\tau}{\sigma^2}\right)}}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}\frac{1}{\Gamma(j+1)j!}\left(\frac{\alpha s-\tau s}{2\sigma^2}\right)^{2j}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{\frac{(\alpha\tau-\tau^2)}{\sigma^4}}{\Gamma(j+1)j!}\left(\frac{\alpha s-\tau s}{2\sigma^2}\right)^{2j}\frac{e^{-\left(\frac{\tau^2}{\sigma^2}\right)}e^{-\left(\frac{\alpha\tau}{\sigma^2}\right)}}{\Gamma(k+1)k!}\left(\frac{\tau s}{2\sigma^2}\right)^{2k}d\tau$$

$$f_{\alpha}(\alpha)=\int_0^{\alpha}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{\alpha^{2k}s^{2k}\tau^{2k+1}-\tau^{2k+2}s^{2k}\ (\alpha s-\tau s)^{2j}}{\Gamma(j+1)j!\ \ \sigma^{4j+4}2^{2j+1}}\frac{e^{-\left(\frac{\tau^2}{\sigma^2}\right)}e^{-\left(\frac{\alpha\tau}{\sigma^2}\right)}}{\Gamma(k+1)k!}d\tau$$

The above equation can be calculated from [2, Eq. (1.211)]

$$f_{\alpha}(\alpha)=\int_0^{\alpha}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\frac{\alpha^{2k}s^{2k}\tau^{2k+1}-\tau^{2k+2}s^{2k}}{\Gamma(j+1)j!\ \ \sigma^{4j+4}2^{2j+1}}\sum_{a=0}^{2j}\binom{2j}{a}(-\tau s)^a\alpha s^{2j-a}$$

$$\times\sum_{b=0}^{\infty}\frac{\left(-\frac{\tau^2}{\sigma^2}\right)^b}{b!}\sum_{c=0}^{\infty}\frac{\left(-\frac{\alpha\tau}{\sigma^2}\right)^c}{c!}\frac{1}{\Gamma(k+1)k!}d\tau$$

$$f_{\alpha_{EGC}}(\alpha)=\int_0^{\alpha}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\sum_{a=0}^{2j}\sum_{b=0}^{\infty}\sum_{c=0}^{\infty}\frac{\alpha^{2k}s^{2k}\tau^{2k+1}-\tau^{2k+2}s^{2k}}{\Gamma(j+1)j!\ \ \sigma^{4j+4}2^{2j+1}}\binom{2j}{a}(-1)^a(\tau s)^a$$

$$\times\ \alpha s)^{2j-a}\frac{(-1)^b\left(\frac{\tau^2}{\sigma^2}\right)^b}{b!}\frac{(-1)^c\left(\frac{\alpha\tau}{\sigma^2}\right)^c}{c!}\frac{1}{\Gamma(k+1)k!}d\tau$$

$$f_{\alpha}(\alpha)$$

$$=\int_0^{\alpha}e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)}e^{-\left(\frac{s^2}{\sigma^2}\right)}\sum_{k=0}^{\infty}\sum_{j=0}^{\infty}\sum_{a=0}^{2j}\sum_{b=0}^{\infty}\sum_{c=0}^{\infty}\binom{2j}{a}\frac{1}{\Gamma(j+1)j!\ \ \sigma^{4j+4}2^{2j+1}}\frac{1}{\Gamma(k+1)k!}\times(-1)^{a+b+c}(\alpha^{2k}s^{2k}\tau^{2k+1}$$

$$-s^{2k}\tau^{2k+2})\tau^{a+2b+c}\quad s^a\frac{\alpha^c}{\sigma^{2(b+c)}b!\,c!}\ d\tau$$

$$f_{\alpha}(\alpha) = \int_0^{\alpha} e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)} e^{-\left(\frac{s^2}{\sigma^2}\right)} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \binom{2j}{a} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4} 2^{2j+1}} \frac{1}{\Gamma(k+1)k!} \times (-1)^{a+b+c} (\alpha^{2k} s^{2k+a} \tau^{2k+a+2b+c+1} - s^{2k+a} \tau^{2k+a+2b+c+2}) \frac{\alpha^c}{\sigma^{2(b+c)} b!\, c!} d\tau$$

$$f_{\alpha}(\alpha) = \int_0^{\alpha} e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)} e^{-\left(\frac{s^2}{\sigma^2}\right)} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \binom{2j}{a} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4} 2^{2j+1}} \frac{1}{\Gamma(k+1)k!} \times (-1)^{a+b+c} \frac{\alpha^c}{\sigma^{2(b+c)} b!\, c!} (\alpha^{2k} s^{2k+a} \ldots - s^{2k+a} \tau^{2k+a+2b+c+2}) \quad d\tau$$

$$f_{\alpha}(\alpha) = e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)} e^{-\left(\frac{s^2}{\sigma^2}\right)} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \binom{2j}{a} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4} 2^{2j+1}} \frac{1}{\Gamma(k+1)k!} \times (-1)^{a+b+c} \frac{\alpha^c}{\sigma^{2(b+c)} b!\, c!} \left(\alpha^{2k} s^{2k+a} \frac{\alpha^{2k+a+2b+c+2}}{2k+a+2b+c+2} - s^{2k+a} \frac{\alpha^{2k+a+2b+c+3}}{2k+a+2b+c+3}\right)$$

$$f_{\alpha}(\alpha) = e^{-\left(\frac{\alpha^2}{2\sigma^2}\right)} e^{-\left(\frac{s^2}{\sigma^2}\right)} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4} 2^{2j+1}} \frac{1}{\Gamma(k+1)k!} \binom{2j}{a} \times (-1)^{a+b+c} \frac{s^{2k+a}}{\sigma^{2(b+c)} b!c!} \left(\frac{\alpha^{4k+a+2b+2c+2}}{2k+a+2b+c+2} - \frac{\alpha^{2k+a+2b+2c+3}}{2k+a+2b+c+3}\right) \quad (18)$$

PDF of SNR is

By applying the value of $\alpha = 2\sqrt{\gamma}$ in equation 18 we get

$$f_{\gamma_{EGC}}(\gamma) = \frac{1}{\sqrt{\gamma}} f_{\alpha_{EGC}}(2\sqrt{\gamma})$$

$$f_{\gamma_{EGC}}(\gamma) = e^{-\frac{4\gamma}{2\sigma^2}} e^{-\frac{s^2}{\sigma^2}} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \frac{1}{\Gamma(k+1)k!} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4}\, 2^{j+1}} \binom{2j}{a} \times (-1)^{a+b+c} \frac{s^{2k+a}}{\sigma^{2(b+c)} b!c!} \left(\frac{2^{4k+a+2b+2c+2} \gamma^{2k+\frac{a}{2}+b+c+\frac{1}{2}}}{2k+a+2b+c+3} - \frac{2^{2k+a+2b+2c+3} \gamma^{k+\frac{a}{2}+b+c+1}}{2k+a+2b+c+3}\right) \quad (19)$$

Outage Probability of Equal Gain Combining

$$P_{out} = F_{\gamma_{EGC}}(u) = \int_0^u f_{\gamma_{EGC}}(\gamma)$$

$$F_{\gamma_{EGC}}(u) = \int_0^u e^{-\frac{4\gamma}{2\sigma^2}} e^{-\frac{s^2}{\sigma^2}} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \frac{1}{\Gamma(k+1)k!} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4}\, 2^{j+1}} \binom{2j}{a} \times (-1)^{a+b+c} \frac{s^{2k+a}}{\sigma^{2(b+c)} b!c!} \left(\frac{2^{4k+a+2b+2c+2} \gamma^{2k+\frac{a}{2}+b+c+\frac{1}{2}}}{2k+a+2b+c+3} - \frac{2^{2k+a+2b+2c+3} \gamma^{k+\frac{a}{2}+b+c+1}}{2k+a+2b+c+3}\right) d\gamma$$

$$F_{\gamma_{EGC}}(u) = e^{-\frac{4\gamma}{2\sigma^2}} e^{-\frac{s^2}{\sigma^2}} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \frac{1}{\Gamma(k+1)k!} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4}\, 2^{j+1}} \binom{2j}{a} \times (-1)^{a+b+c} \frac{s^{2k+a}}{\sigma^{2(b+c)} b!\, c!} \int_0^u \left(\frac{2^{4k+a+2b+2c+2} \gamma^{2k+\frac{a}{2}+b+c+\frac{1}{2}}}{2k+a+2b+c+3} - \frac{2^{2k+a+2b+2c+3} \gamma^{k+\frac{a}{2}+b+c+1}}{2k+a+2b+c+3}\right) d\gamma$$

$$F_{\gamma_{EGC}}(u) = e^{-\frac{4\gamma}{2\sigma^2}} e^{-\frac{s^2}{\sigma^2}} \sum_{k=0}^{\infty} \sum_{j=0}^{\infty} \sum_{a=0}^{2j} \sum_{b=0}^{\infty} \sum_{c=0}^{\infty} \frac{1}{\Gamma(k+1)k!} \frac{1}{\Gamma(j+1)j!\ \sigma^{4j+4}\, 2^{j+1}} \binom{2j}{a}$$

$$\times (-1)^{a+b+c}\ \frac{s^{2k+a}}{\sigma^{2(b+c)}b!c!}\left(\frac{2^{4k+a+2b+2c+2}\,\frac{u^{2k+\frac{a}{2}+b+c+\frac{3}{2}}}{2k+\frac{a}{2}+b+c+\frac{3}{2}}}{2k+a+2b+c+3}-\frac{2^{2k+a+2b+2c+3}\,\frac{u^{k+\frac{a}{2}+b+c+2}}{k+\frac{a}{2}+b+c+2}}{2k+a+2b+c+3}\right) \tag{20}$$

3.4 Switch and Stay Combining (SSC)

SSC further simplifies the complexities of SC. In this in place of continually connecting the diversity path with best quality, a particular diversity path is selected by the receiver till the quality of the path drops below a predetermined threshold. When it happens, then the receiver switches to another diversity path. This reduces the complexities relative to SC, because continuous and simultaneous monitoring of all diversity paths in not required. The CDF of SNR of SSC is given [5] as

Outage Probability P_{out} of SSC is evaluated from [5, Eq.(9.270)]

$$P_{\gamma_{SSC}}(\gamma) = \begin{cases} P\gamma(\gamma_T)P\gamma(\gamma) & \gamma < \gamma_T \\ P\gamma(\gamma) - P\gamma(\gamma_T) + P\gamma(\gamma)P\gamma(\gamma_T) & \gamma \geq \gamma_T \end{cases} \tag{21}$$

Where γ_T is switching threshold

$$P_\gamma(\gamma) = \frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\,\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(\boldsymbol{k+1},\ \frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{k+1}}}\right] \tag{22}$$

$$P_\gamma(\gamma_T) = \frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\,\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(\boldsymbol{j+1},\ \frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{j+1}}}\right] \tag{23}$$

The Outage Probability of SSC can be calculated from Eq. (22)&(23)

When $\gamma < \gamma_T$

$$P_{\gamma_{SSC}}(\gamma) = P_\gamma(\gamma_T)\, P_\gamma(\gamma)$$

$$P_{\gamma_{SSC}}(\gamma) = \left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\,\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(\boldsymbol{j+1},\ \frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{j+1}}}\right]\right]\left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\,\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(\boldsymbol{k+1},\ \frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{k+1}}}\right]\right]$$

$$P_{\gamma_{SSC}}(\gamma) = \left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\,\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(\boldsymbol{j+1},\ \frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{j+1}}}\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\,\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(\boldsymbol{k+1},\ \frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{k+1}}}\right]$$

$$P_{\gamma_{SSC}}(\gamma) = \left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(j+1,\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{j+1}}\ \frac{\Gamma\left(k+1,\frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right] \tag{24}$$

When $\gamma \geq \gamma_T$

$$P_{\gamma_{SSC}}(\gamma) = P_\gamma(\gamma) - P_\gamma(\gamma_T) + P_\gamma(\gamma)\, P_\gamma(\gamma_T)$$

$$P_{\gamma_{SSC}}(\gamma) = \left[\left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\,\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(\boldsymbol{k+1},\ \frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{k+1}}}\right]\right] - \left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\left[\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\,\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(\boldsymbol{j+1},\ \frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{\boldsymbol{j+1}}}\right]\right]\right.$$

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$$+\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2 \left[\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(j+1,\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{j+1}}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(k+1,\frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right]\Bigg]$$

$$P_{\gamma_{SSC}}(\gamma)=\left[\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]\left[\sum_{k=0}^{\infty}\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(k+1,\frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right]-\left[\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2 \frac{\Gamma\left(\boldsymbol{j}+\mathbf{1},\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{\mathbf{1}}{\bar{\gamma}}\right)^{\boldsymbol{j}+\mathbf{1}}}\right]\right.$$

$$\left.+\left[\frac{e^{-\frac{(s^2)}{\bar{\gamma}}}}{\bar{\gamma}}\right]^2\left[\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2\left(\frac{s^k}{k!\bar{\gamma}^k}\right)^2 \frac{\Gamma\left(j+1,\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{j+1}}\frac{\Gamma\left(k+1,\frac{\gamma}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{k+1}}\right]\right] \quad (25)$$

PDF of SCC is evaluated from [5, Eq.(9.274)]

$$p_{\gamma_{SSC}}(\gamma)=\frac{dP_{\gamma_{SSC}}(\gamma)}{d\gamma}=\begin{cases} P\gamma(\gamma_T)p\gamma(\gamma)\gamma<\gamma_T \\ 1+P\gamma(\gamma_T)p\gamma(\gamma)\gamma\geq\gamma_T\end{cases} \quad (26)$$

Where PDF of SNR is

$$p_\gamma(\gamma)=\frac{1}{\bar{\gamma}}e^{-\frac{(\gamma+s^2)}{\bar{\gamma}}}\sum_{k=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma}\,s}{\bar{\gamma}}\right)^{2k}$$

When $\gamma < \gamma_T$

$p_{\gamma_{SSC}}(\gamma) = P_\gamma(\gamma_T)\, p_\gamma(\gamma)$

$$p_{\gamma_{SSC}}(\gamma)=\left[\frac{e^{-\frac{s^2}{\bar{\gamma}}}}{\bar{\gamma}}\sum_{j=0}^{\infty}\left(\frac{s^j}{j!\,\bar{\gamma}^j}\right)^2\frac{\Gamma\left(\boldsymbol{j}+\mathbf{1},\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{\mathbf{1}}{\bar{\gamma}}\right)^{\boldsymbol{j}+\mathbf{1}}}\right]\left[\frac{1}{\bar{\gamma}}e^{-\frac{(\gamma+s^2)}{\bar{\gamma}}}\sum_{k=0}^{\infty}\frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma}\,s}{\bar{\gamma}}\right)^{2k}\right]$$

$$p_{\gamma_{SSC}}(\gamma)=\frac{e^{-\frac{(\gamma+2s^2)}{\bar{\gamma}}}}{\bar{\gamma}^2}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2\frac{\Gamma\left(j+1,\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{j+1}}\frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma}s}{\bar{\gamma}}\right)^{2k} \quad (27)$$

When $\gamma \geq \gamma_T$

$p_{\gamma_{SSC}}(\gamma) = 1 + P_\gamma(\gamma_T)\, p_\gamma(\gamma)$

$$p_{\gamma_{SSC}}(\gamma)=1+\frac{e^{-\frac{(\gamma+2s^2)}{\bar{\gamma}}}}{\bar{\gamma}^2}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\left(\frac{s^j}{j!\bar{\gamma}^j}\right)^2\frac{\Gamma\left(j+1,\frac{\gamma_T}{\bar{\gamma}}\right)}{\left(\frac{1}{\bar{\gamma}}\right)^{j+1}}\frac{1}{\Gamma(k+1)k!}\left(\frac{\sqrt{\gamma}s}{\bar{\gamma}}\right)^{2k} \quad (28)$$

IV SIMULATION RESULTS

The rician fading model is presented in fig.1 when the rice factor is 0 the channel works as rayleigh distribution and average SNR is equal to the received SNR. When the value of rice factor is 1 it works as Rician distribution and the average SNR increases. The outage probability is shown in fig.2 for K=0.It shows that at 8 dB SNR outage probability of SSC is $10^{-1.7}$, for SC is $10^{-1.9}$, for EGC is $10^{-1.95}$ and for MRC$10^{-2.0}$, the outage performance improves from (from

SSC to MRC) $10^{-1.7}$ to $10^{-2.0}$. Infig.3 the outage probability for K=1is shown by which it is determined that the outage probability improves to $10^{-2.9}$ in case of MRC. Threshold of receiver is shown in fig.4 and 5 which indicates that receiver threshold is better for MRC and higher value of K. By these results we can conclude that MRC is giving better performance than other combining techniques. The Rice factor K plays a vital role for the performance of the channel when the value of K increases the performance improves.

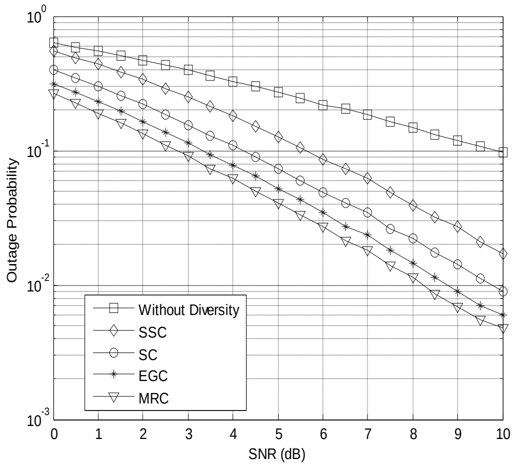

Fig.2. Outage Probability for K=0

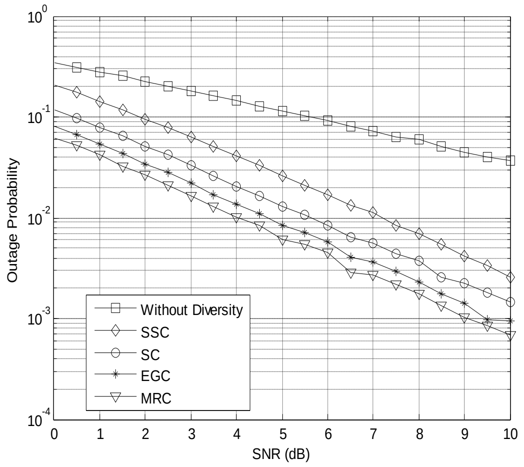

Fig.3. Outage Probability for K=1

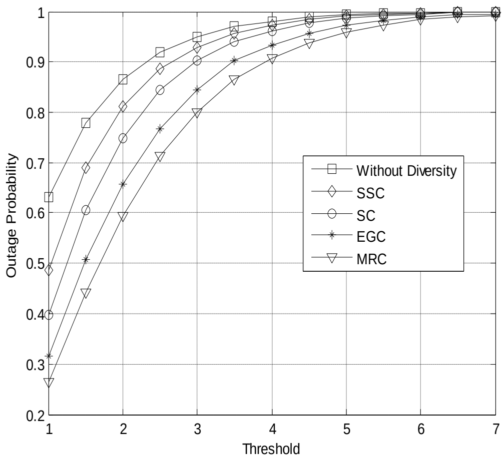

Fig.4 Threshold for Rician Fading Channel for K=0

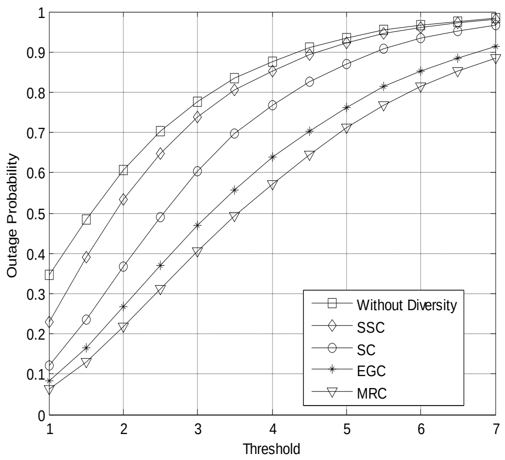

Fig.5 Threshold for Rician Fading Channel for K=1

V. CONCLUSION

In this paper probability distribution function,cumulative distribution function and outage probability of selection combining, maximal ratio combining, switch and stay combining, equal gain combining have been analysed. The simulation result shows that the outage performance of maximal ratio combining is better than all other combining techniques in both cases of the value of K is 0 as well as 1. By this analysis we can conclude that the combining technique and rice factor plays a vital role in Rician fading channel.

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