Equal Gain Combiner Output Data for Density Functions

Borivoje Milosevic, Mihajlo Stefanovic, Slobodan Obradovic and Srdjan Jovkovic
Technical College University of Nis
A. Medvedeva 20, Nis 18000
Serbia
borivojemilosevic@yahoo.com

ABSTRACT: *With the EGC diversity combiner, we have applied the MATLAB system for testing the Rayleigh Fading in this work. We have considered this Equal Gain Combiner for this research and outlined the uncorrelated Rayleigh Fading. We have measured the cumulative density function and dual EGC output signals and the joint output signal. Further we present the results of the probability density function data and the equal gain combiner output signals data.*

Keywords: EGC, PDF, CDF, Fading, Rayleigh, Combiner

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1. Introduction

Problems that occur during the implementation of applications for statistical analysis of signal in the presence of fading are mainly related to difficulties in editing formulas and expressions, their computation (Mathematica), drawing graphics (Origin), etc. This paper provides a simpler approach to solving this problem, of course, using an excellent tool: MATLAB.

Some of the most well-known diversity techniques are MRC (Maximum Ratio Combining), EGC (Eqal Gain Combining) and SC (Selection Combining) [1]. Around them, EGC presents significant practical interest, because it provides performance comparable to MRC but with simpler implementation complexity. In EGC, the desired signals of the output of the two antennas are caphased, equally weighted and then summed to give the desired resultant signal.

Diversity combining is one of the most practical, effective and widely emplayed techniqes in digital communication receivers for mitigating the effect of multipath fading and improving the overall wirless systems performance.

The performance of EGC, assuming independet channel fading, has been studied extensively in the literature, although there are less published results concerning EGC receiver, compared with those of other the diversity methods, such are MRC and SC. This lack is mainly due to the difficulty of finding the probability density function (PDF) and cummulative distributions function (CDF) of the EGC output signal to noise ratio (SNV) [3]. However, independent fading is not always realised in practice due to insufficient antena spacing. Therefore, it is important to understand how the correlation betwen received signals effect the offered diversity gain. Reviewing the literature, it can be seen that there are few approaches for the performance evaluation of predetection EGC over correlated fading channels.

2. Exposition

2.1. Choice of Mathematical Methods and Mathematical Modeling Problems

When analyzing the process of propagation of digital communication systems, methods and models of statistical theory of telecommunications are to be used. The accuracy of proposed model will be checked by deductive methods and simulation systems for known cases. In doing so, it is very important to set the criteria for selection of models, each of which has its advantages and disadvantages, which must be viewed through the purpose of a certain type of software.

When choosing to be analyzed:

• Why it is purchased

• Who will use it

• What is the expected benefit

Analysis of the previous factors significantly narrows the circle of appropriate tools. Within such a selection, the remaining tools need to be paid attention to the following factors:

• Flexibility of use

• Whether the tool is known by a customer

• Purchase price and maintenance tools

• Tools mobility

For design software package, the most modern will be used methods, techniques and principles of agile, modular, procedural and object-oriented programming. They will be used to generate a regular expression applied methods of symbolic data processing.

In addition, several mathematical models and methods have been developed for solving the problem of fading phenomenon and improve the quality of digital telecommunications data transmission. Examples of these models are described by Rice, Rayleigh, Nakagami, Veibull and Log-normal fading distribution. Since there are no specific requirements for performing mathematical calculations and simulation, implementation and calculating complex mathematical functions and expressions, visualizing the results and creating dynamic GUI_a, the main problem we had to solve was the application of an appropriate application program that could meet all the listed requirements, but at the same time be flexible to use, be a tool known to the user, be unrestricted portability tool, that is stable and fast (because some processes of calculation in the loop require a large number of iterations to meet the convergence conditions, and therefore spend a lot of processor time). All my thoughts regarding this issue boiled down mainly to the selection and application of extraordinary application program: MATLAB.

The work is part of a " Software Package to Determining the Performance of Digital Telecommunications Systems in The Presence of Fading ".

2.2. Calculation and plotting PDF

The application allows the user to start, a simple click of the mouse, calculate and draw the basic elements of the statistical theory of telecommunication channels, statistical parameters of the first order system in the channel with the Rayleigh fading by two functions: the probability density and cummulative probability density.

One of the most common methods for characterizing a fading channel is the use of a probability density function (PDF), which represents the probability density of the received signal strength. The shape of a PDF determines the performance of a wireless receiver in the presence of noise and interference. Figure 1 shows probability density function EGC Diversity receivers with two branches and Rayleigh fading.

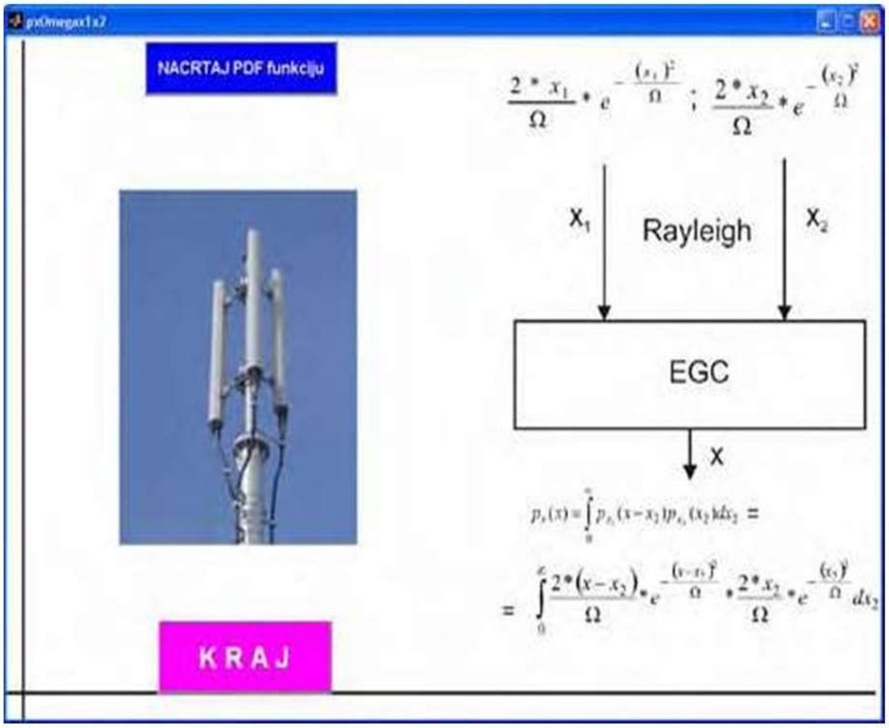

Figure 1. Probability density function EGC Diversity receivers with two branches and Rayleigh fading

```
% The expression for the probability density function of %EGC Diversity receivers with two branches and Rayleigh

%fading with MATLAB solutions********************
……………………………..
for x=0:0.05:6;

Omega=0.4;
PP=@(x2) (2.*(x - x2))./(Omega).*exp(-((x -
x2).^2/(Omega))).*(2.*x2)./(Omega).* exp (-
((x2).^2./(Omega)));
P=quad(PP,0,x);
Omega=0.5;
PP1=@(x2) (2.*(x - x2))./(Omega).*exp(-((x -
x2).^2/(Omega))).*(2.*x2)./(Omega).* exp (-
((x2).^2./(Omega)));
P1=quad(PP1,0,x);
Omega=0.7;
```

```
PP2=@(x2) (2.*(x - x2))./(Omega).*exp(-((x - x2).^2
/(Omega))).*(2.*x2)./(Omega).* exp (-((x2).^2./(Omega)));
P2=quad(PP2,0,x);
Omega=0.8;
PP3=@(x2) (2.*(x - x2))./(Omega).*exp(-((x - x2).^2
/(Omega))).*(2.*x2)./(Omega).* exp (-((x2).^2./(Omega)));
P3=quad(PP3,0,x);
% Create plot in proper axes
plot (x,P,'bx-','LineWidth',2);
hold on
plot (x,P1,'rd-','LineWidth',2);
plot (x,P2,'mp-','LineWidth',2);
plot (x,P3,'ko-','LineWidth',2);
axis([0 6 0 1])
grid on
legend('Omega=0.4','Omega=0.5','Omega=0.7','Omega=0.8');
xlabel('x—>');
ylabel('PDF');
title('PDF za SC diverziti sa dva ulaza i Rejlijevim kanalima');
end
```

Figure 2 shows probability density graph of the EGC Diversity receivers with two branches and Rayleigh fading.

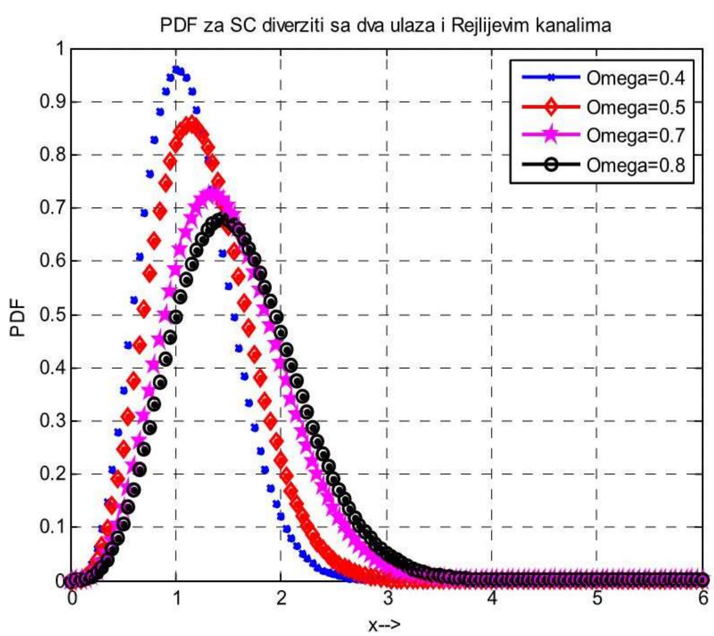

Figure 2. Probability density graf EGC Diversity receivers with two branches and Rayleigh fading vs. Omega

2.3. Calculation and plotting CDF

Using cummulative probability, the probability of the system signal is determined. Probability of the system is defined, as the signal has less than some allowable value. Using probability density signal, the capacity of the channel is determined. Channel capacity is obtained by averaging the Shannon 's terms of channel capacity. Using the moment of the signal at the output of macro diversity systems we can calculate the amount of fading. Using the joint probability density signals and extracting the signal at the output of the micro-diversity systems in operation is determined by the joint probability density signal and performs the signal at the output of macro diversity systems.

Using the bit error probability and failure probabilities we can determine the signal strength and distance connections, depending on the parameters of fading and interference. On the basis of these elements it is proved that the application of these techniques can be used by transmitters with less power at greater distances. Using the joint probability density of signal and derivative of the signal we can determine the level crossing rate of signals. Average number of signal level crossing rate is equal to the average of the first derivative of the signal. Using the signal level crossing rate we can determine the duration of the signal. Mean value of the duration of the signal is equal to the error probability quotient failure and the mean number of signal level crossing rate.

Figure 3 shows cummulative probability density function CDF Diversity receivers with two branches and Rayleigh fading.

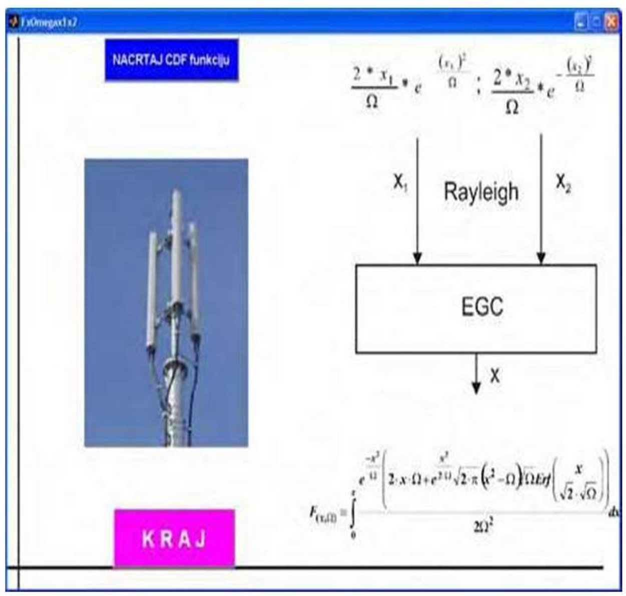

Figure 3. Cummulative probability density function CDF Diversity receivers with two branches and Rayleigh fading

Next calculation model is based on the same receiver, only the case is calculating the cummulative probability density function of the signal at the output of the EGC combiner. Receiver has two independent branches with Rayleigh fading.

% The expression for the cummulative probability density function CDF of diversity receivers with two branches and Rayleigh fading with MATLAB solutions***************

```
for x=0:0.05:3.5;
Omega=0.4;
PP1=@(x)(exp((-x.^2.)/(Omega)).*(2.*x.*Omega+
exp((x.^2.)/(2.*Omega)).*sqrt(2.*pi).*(x.^2- Omega).*sqrt(Omega).*erf(x./sqrt(2.*Omega)))))./(2.*Omega. ^2);
P1=quad(PP1,0,x);
Omega=0.5;
```

```
PP2=@(x) (exp((-x.^2.)/(Omega)).*(2.*x.*Omega+
exp((x.^2.)/(2.*Omega)).*sqrt(2.*pi).*(x.^2-
Omega).*sqrt(Omega).*erf(x./sqrt(2.*Omega)))))./(2.*Omega. ^2);
P2=quad(PP2,0,x);
Omega=0.7;
PP3=@(x)(exp((-x.^2.)/(Omega)).*(2.*x.*Omega+
exp((x.^2.)/(2.*Omega)).*sqrt(2.*pi).*(x.^2- Omega).*sqrt(Omega).*erf(x./sqrt(2.*Omega)))))./(2.*Omega. ^2);
P3=quad(PP3,0,x);
Omega=0.8;
PP4=@(x)(exp((-x.^2.)/(Omega)).*(2.*x.*Omega+
exp((x.^2.)/(2.*Omega)).*sqrt(2.*pi).*(x.^2-
Omega).*sqrt(Omega).*erf(x./sqrt(2.*Omega)))))./(2.*Omega. ^2);
P4=quad(PP4,0,x);
% Create plot in proper axes
plot (x,P1,'bx-','LineWidth',2);
hold on
plot (x,P2,'rd-','LineWidth',2);
plot (x,P3,'mp-','LineWidth',2);
plot (x,P4,'ko-','LineWidth',2);
axis([0 4 0 1])
grid on legend('Omega=0.4','Omega=0.5','Omega=0.7','Omega=0.8');
xlabel('x-->');
ylabel('CDF');
title('CDF za EGC diverziti sa dva ulaza i Rejlijevim kanalima');
end
```

3. Conclusion

In this paper statistical probability of the signals gain of combining output signals in the presence of Rayleigh fading is determined using MATLAB application. The probability density function of the output signal in the presence of Rayleigh fading channel is obtained. Input EGC combiner works by the summed input symbols and on the basis of the sum the decisions are made. In EGC (Fqual Gain Combining) ways of combining the signal at the output are equal to the sum of the signal from its input. This way of combining shows slightly lower scores than the MRC combining, but is more suitable for implementation because it takes the signal input lead in phase and it makes it not necessary to estimate the parameters of the channel. Numericaly evaluated results were presented, showing the effects of fading severity on the system' s performance.

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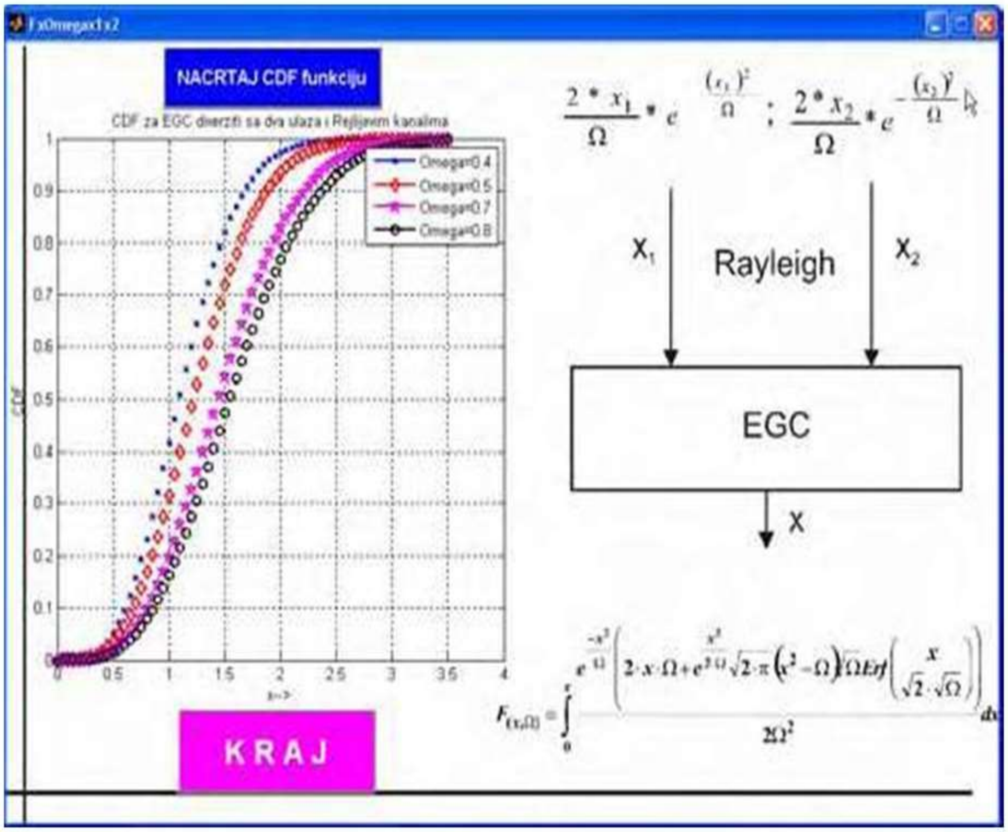

Figure 4. Cummulative probability density graph of the CDF Diversity receivers with two branches and Rayleigh fading vs. Omega

Figure 4 shows cummulative probability density graph of the CDF Diversity receivers with two branches and Rayleigh fading

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