BLIND PARAMETER ESTIMATION WITH GENETIC ALGORITHM IN WIRELESS FADING CHANNELS

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ABSTRACT
In this paper, the performance of genetic algorithm (GA) is presented to estimate the blind channel parameters**.** 8-PSK signals are considered as modulation scheme. Channel is assumed as AWGN and has Rician probability distribution. Furthermore, channel is slow fading channel and channel parameters are assumed to be constant during the transmission of ten signals. Noisy and faded signals are observed from the receiver. GA is applied to estimate the channel parameters. For different fading channels and signal-to-noise ratios (SNR), the mean errors of the estimated channel parameters are obtained.

Keywords: Channel Parameter Estimation, Genetic Algorithm, Fading Channels.

SÖNÜMLEMELİ KANALLARDA GENETİK ALGORİTMA İLE GÖZÜ KAPALI PARAMETRE KESTİRİMİ

ÖZET
Bu makalede gözü kapalı kanal parametre kestirimi için genetik algoritma (GA) başarımı sunulmuştur. 8-PSK modülasyon yöntemi göz önüne alınmıştır. Kanalın AWGN ve Rician dağılımlı olduğu kabul edilmiştir. Kanalın yavaş değişen sönümlemeli kanal olduğu ve on sinyal boyunca parametrelerinin sabit kaldığı varsayılmıştır. Alıcıda gürültülü ve sönümlenmiş sinyaller gözlemlenir. GA kanal parametrelerini kestirmek için kullanılır. Farklı sönümlemeli kannallar ve sinyal gürültü oranları için kestirilen kanal parametrelerindeki ortalama hata hesaplanmıştır.

Anahtar Kelimeler: Kanal Parameter Kestirimi, Genetik Algoritma, Sönümlemeli Kanallar.

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1. INTRODUCTION

Many cases of digital transmission are subject to fading due to multi-path reflections and phase jitter due to Doppler shift. In mobile satellite communication, multi-path can be modeled by Rician statistics (Divsalar and Simon, 1987) and phase jitter can be modeled by Tikhonov distribution. Hence, estimation of Rician fading channel parameters is of considerable practical interest and worth further investigation.

We know that Maximum Likelihood (ML) estimation algorithm performs satisfactorily when only a short data record is available (Divsalar and Simon, 1987). However, implementation of the method of ML is fairly used for the blind problem at hand. Hidden Markov model formulation of the problem should be considered and the computationally efficient Baum-Welch algorithm can be employed in order to find ML estimates of the distribution parameters of the Hidden Markov chain (Baum et.al.,1970; Rabiner, 1989; Kaleh and Vallet, 1994).

Baum-Welch algorithm was originally developed for the purpose of finding the ML estimates of the distribution parameters of a Markov chain probabilistic function and has been widely employed to adjust the model parameters of Hidden Markov Model's (HMM) in the context of speech processing. It has also been applied to communication and source separation problems for estimating linear and non-linear parameters (Baum et.al.,1970).

Genetic algorithms (GAs) are known to be robust, stochastic search methods applicable to a great variety of difficult problems. Especially for many combinatorial problems as e.g. the *traveling salesman problem*, GAs have proven to be very well suited and sometimes much more efficient than other known optimization techniques. Since a GA works on a population of solutions and not only with a single current, it has greater potentialities to escape from local optima without completely losing found regions in the search space containing high quality solutions (Goldberg, 1989). Thus, we use GA to estimate the channel parameters, which influence the transmitted signal in multi-path fading channel.

2. THE EFFECT OF THE CHANNEL

Here, we assume that the modulation type is chosen as 8-PSK as shown in Figure 1. Signal constellation $\mathbf{s} \in \{s_0, s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$and can be shown in the complex system as,

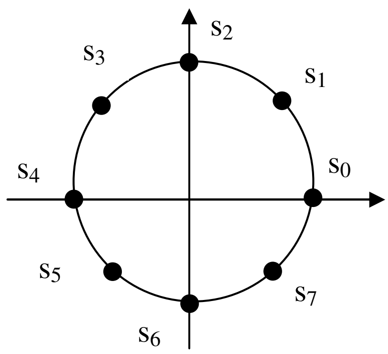

Figure 1. 8-PSK signal constellation

The main emphasis of this section is to show the effect of the fading channel, which is modeled by Rician probability density function, on 8-PSK signals. Thus, our results reflect the degradations due to the effect of fading on the amplitude of the received signal. The diagram of the considered system operating over Rician fading environment is shown in Figure 2.

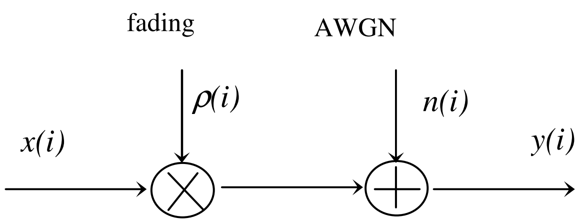

Figure 2. Channel effect

At the channel output $y(i)$ is,

$$y(i) = \rho(i) \cdot x(i) + n(i) \quad (1)$$

$n(i)$ is Gaussian Noise where the noise variance is $\sigma^2 = N_o/2E_s$, $\rho(i)$ is fading amplitude and has Rician probability density function (pdf) and can be written as,

$$P(\rho) = 2\rho(1+K)\; e^{(-\rho^2(1+K)-K)} I_o\left[2\rho \cdot \sqrt{K(1+K)}\right] \tag{2}$$

where I_0 is the modified Bessel function of the first kind, order zero and K is fading parameter. Rician pdf turns into Rayleigh pdf if parameter K is chosen as 0.

3. GENETIC ALGORITHM

GAs are algorithms that operate on a finite set of points, called a *population*. The different populations are interpreted as *generations*. Each individual of the population has chromosomes, which consist of ones and zeros. The length of the chromosome indicates the precision of binary representation of decimal value. Each individual can be shown as,

$$\mathbf{c} = c_1 c_2 c_3 c_4 .... c_p \qquad c_i \in \{1,0\} \tag{3}$$

If p is chosen as a large number, the precision would be better but the process takes more time.

The purpose of using GAs is to find the suitable individual in a population, which minimizes the error function. Here, we would like to find the fading parameter ρ for 10 signals, which minimizes our error function, MSE (mean square error).

$$MSE = \sum_{t=1}^{10} \left| \prod_{k=0}^{7} (y(t) - \rho \, . \, s(k)) \right|^2 \tag{4}$$

After computing (4) for each individual, best individuals are chosen, the others are dismissed and the number of the population is obtained from the repetition of the best individuals. Then, every two random individual forms a group and cross-over operation is applied. In this operation, some parts of each individual are combined with the other individual and two different chromosome structures are obtained. Afterwards, mutation operation is applied. Mutation changes some of the chromosomes according to the mutation ratio.

When all these operations are finished, new generation has just been obtained and same operations are applied. In our simulation, we designated the population as 200 individuals and each of them consists of 10 chromosomes for 2^{10} precision between the boundaries of the channel parameter ρ which are chosen as 0.3 and 1.6. 8^{th} generation is accepted for the minimization of the error function and the best individual is chosen as fading parameter ρ.

In Figure 3, Rician (K=20dB) and Rayleigh channels are chosen to demonstrate the GA performance on the blind estimations of channel parameters. Here, for low level SNRs, mean error is quite high but after 10dB, the results are rather better.

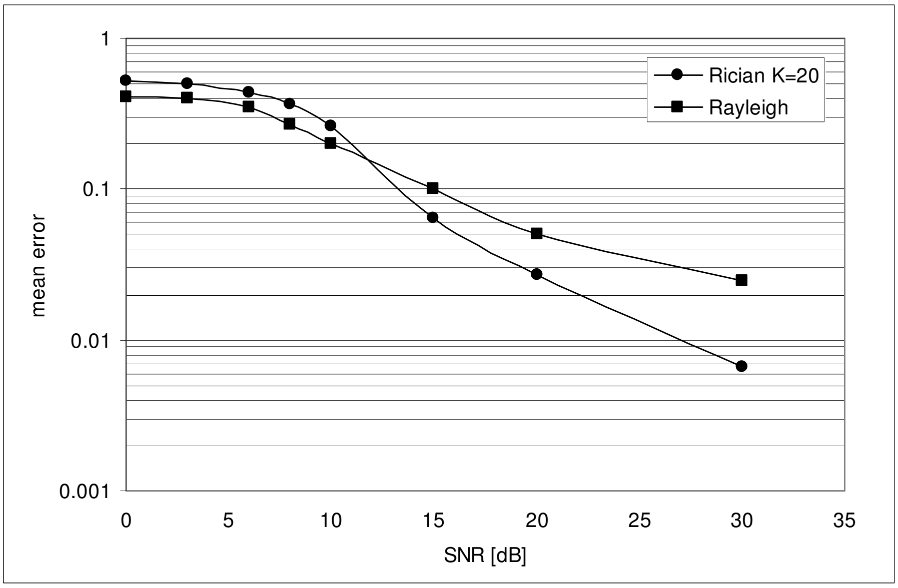

Figure 3. Mean error of the channel parameter in Rician and Rayleigh fading channels

4. CONCLUSION

In this paper, the effects of the Rician and Rayleigh fading channels are considered. Genetic Algorithm is applied to estimate the fading parameter ρ which minimizes the error function. Results for large SNR values are very good but for low SNR, values are not acceptable.

5. REFERENCES

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