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Coherent Modulation Classification of QAM Signals in Presence of Gaussian Noise

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Abstract -In this paper we propose an algorithm for the classification of QAM signal in the presence of Gaussian noise. The additive noise is modeled by Gaussian mixture distribution. A log likelihood algorithm is used to classifying the signal on the basis of decision –theoretic approach and develop a schematic structure of classifier for M-array QAM signals. The performance is evaluated in terms of probability of successful classification. We evaluate the performance of the classifier based on the amplitude density function of received signal.

Key words-modulation classification ,log- likelihood , quadrature amplitude modulation

I- INTRODUCTION

Modulation is a process by which a carrier signal is altered according to information in a message signal. The carrier frequency, denoted Fc, is the frequency of the carrier signal. The sampling rate is the rate at which the message signal is sampled during the simulation. The frequency of the carrier signal is usually much greater than the highest frequency of the input message signal. The Nyquist sampling theorem requires that the simulation sampling rate Fs be greater than two times the sum of the carrier frequency and the highest frequency of the modulated signal in order for the demodulator to recover the message correctly. A modulation classifier estimates characteristics of a radio signals and determines the modulation types based on these characteristics. At receiver the intercepted signal consist of modulated signals perturbed by noise that has been introduced anywhere along the transmission line. Modulation varies the amplitude, phase, or frequency of a carrier signal with reference to a message signal. The modulate function modulates a message signal with a specified modulation method. The demodulated signal is attenuated because demodulation includes two steps: multiplication and low pass filtering. The multiplication produces a component with frequency centered at 0 Hz and a component with frequency at twice the carrier frequency. The filtering removes the higher frequency component of the signal, producing the attenuated result.

II- Modulation Classification

To identify the modulation format of a given signal, statistical properties of the signal are widely used [1]–[3] due to their simplicity in implementation. Maximum likelihood (ML) based schemes [4]–[7], on the other hand, can provide optimal performance at the cost of high complexity. References [8] and [9] present recent advances on these two approaches, respectively. A comprehensive review of MC techniques can be found in [10]. In- coherent environment log likelihood method is used to classifying to QAM signals One nice feature of this method is its immunity to frequency mismatch and phase shift. It is complex to implement, requiring intensive computations due to a special function involved. Another drawback is that it is only valid for time-synchronized QAM signals. All other classifiers developed fo Gaussian noise are *feature*-based; that is, they exploit modulation dependent features of the signal, such as cumulants [1], [11]. QAM is currently more common modulation technique in digital communication. It is also used in analog communication as well as in digital communication. It is a combination of modulation of amplitude and phase. This modulation scheme also known as Quadrature Carrier Multiplexing. In this study, we consider the MC problem in an ideal situation where all signal parameters as well as the noise power are known, and, in addition, the data symbols are independent and the pulse shape is rectangular. There are two main types of QAM constellation square and cross type constellation. 4-QAM, 16-QAM, 64-QAM are square type, where 8-QAM, 32-QAM, 128-QAM are cross type

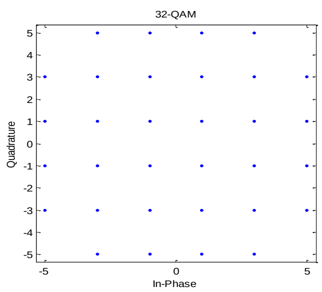

Figure.1 QAM constellation diagram

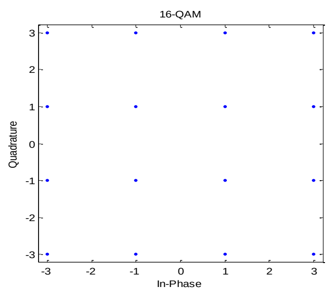

Figure2: QAM constellation diagram

Our goal is to develop a theoretical performance analysis of the generic ML classifier that is applicable to any digital amplitude-phase modulation, including phase-shift keying (PSK), pulse amplitude modulation (PAM), quadrature amplitude modulation (QAM), etc., which are widely used in modern communications. For example, QAM's are used in digital microwave communications, and V.29 , V.34, V.32 V.32bis (which are QAM modulations) are used in telephone-line modems. The technologies used for high-speed internet access, such as ISDN, HDSL, and ADSL, also belong to this category of modulations. In this paper firstly we design the system model in the presence of Gaussian noise .in next section we design the structure of log likelihood classifier .with the help of classifier we determine the QAM signal .then we obtain the result by varying of different sample sizes. and the last section we give the conclusion.

III-Signal model

The received signal consist of message signal and channel noise can be expressed as

$$\mathrm{r(t)} = \mathrm{s_m}\,(\mathrm{t}) + \mathrm{n(t)} \qquad -\infty < t < \infty \qquad (1)$$

The QAM signal$s_m(t)$ is a band-pass signal and can also be expressed in terms of the equivalent low-pass representation as

$$s_{m\,(t)} = a_{mc}\ g(t)\cos(2\pi f_c t) - a_{ms}\ g(t)\cos(2\pi f_c t),$$
$$= R_e[\tilde{s}_m(t)e^{j2\pi f_c}\ \mathrm{t}] \qquad (2)$$

For a zero-mean narrowband Gaussian noise with variance σ^2, the probability density function (pdf) of the amplitude, R, is known as the Rayleigh distribution

$$\mathrm{p(R)} = \frac{\mathrm{R}}{\sigma^2}\mathrm{e}^{-(\mathrm{R}^2/2\sigma^2)}, \qquad \mathrm{R} \geq 0 \qquad (3)$$

To determine the higher M-array QAM signal is represented by

$$\mathrm{p}^{(\mathrm{R})} = \sum_{\mathrm{j}=1}^{\mathrm{k}} \mathrm{w_m[j]\,Re}^{-(\mathrm{R}^2+\mathrm{S}_{\mathrm{MJ}}^2)}/2\mathrm{I}_0(\mathrm{RS}_{\mathrm{M,j}}),$$
$$\mathrm{w_m} = [\mathrm{w1, w2, \ldots\ldots, w[k]}] \qquad \mathrm{R} \geq 0 \qquad (4)$$

Where k represent the number of sets of equal amplitudes on the constellation plane.

IV-Log likelihood classifier

The maximum likelihood classification method choose the hypothesis under which the likelihood or log likelihood function is maximized. an overview of building block of modulation classification maximum likelihood is shown in fig (3)

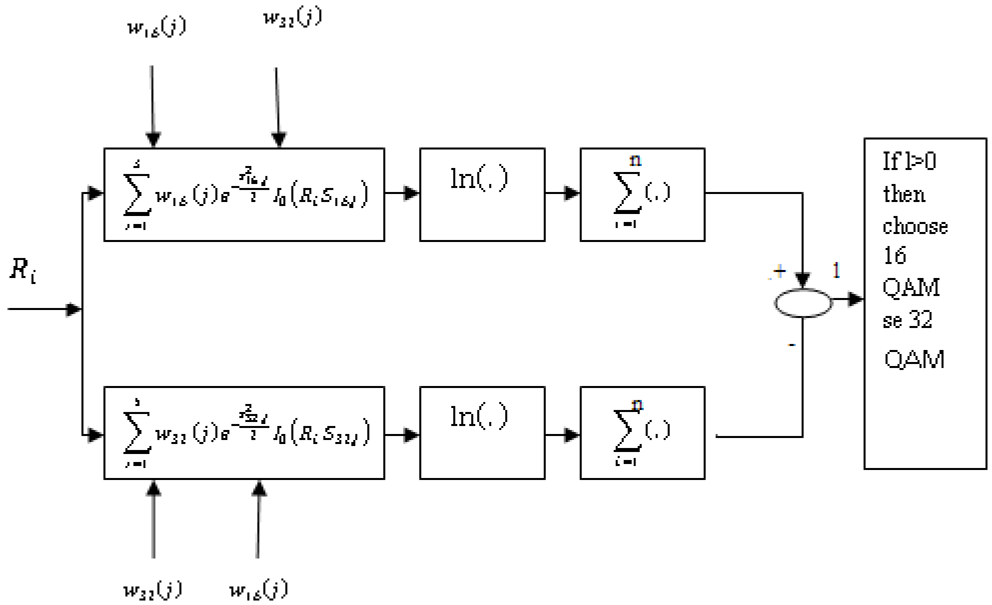

Figure3: structure of 16/32 QAM

Determination of the a posteriori probabilities

$$\mathrm{p(H_\alpha|R_1, R_2, \ldots\ldots\ldots.R_n)}.$$

follows from the mixed form of Bayes rule,

$$\mathrm{p(H_\alpha|R_1, R_2, \ldots\ldots\ldots.R_n)} = \frac{\mathrm{p(R_1, R_2, \ldots\ldots\ldots.R_n|H_\propto)p(H_\propto)}}{\mathrm{P(R_1, R_2, \ldots\ldots\ldots..R_n)}}. \qquad (5)$$

The resultant test statistic for any hypothesis $H_\propto$, $I_\propto$, is, therefore

$$I_\propto = \ln[p(R_1, R_2, \ldots \ldots \ldots . . R_n | H_\propto)]$$

$$= \sum_{i=1}^{n} \ln\left\{\sum_{j=1}^{k} w_M[j]\, e^{-S_{M,j}^2/2} I_0(R_i S_{M,j})\right\}$$

$$\propto = 1,2, \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (6)$$

Eq. (6) can be employed to design a classifier for general *M*-aray QAM signals. Fig. 3 illustrates a schematic structure of QAM signal classifier. It can be observed that the structure is flexible and easy to expand. As an example, suppose that we want to discriminate between 16QAM and 32QAM signal.

V-RESULTS AND DISCUSSION

The analytical expressions have been derived from the log-likelihood algorithm based approach. We simulate the classifier under consideration using MATLAB package. The probability of successful classification is plotted as a function of the SNR. From the Fig-4 it is observed that as the SNR increases, the probability of correct decision also increases. In this Fig-5 the probability of successful classification is plotted for variable number of sample size.

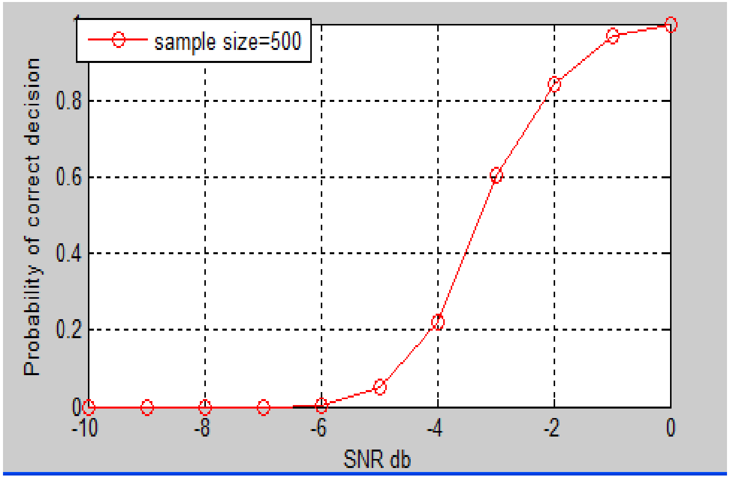

Figure 4.:Performance of ML –Classifier with the sample size of 500 for QAM signals.

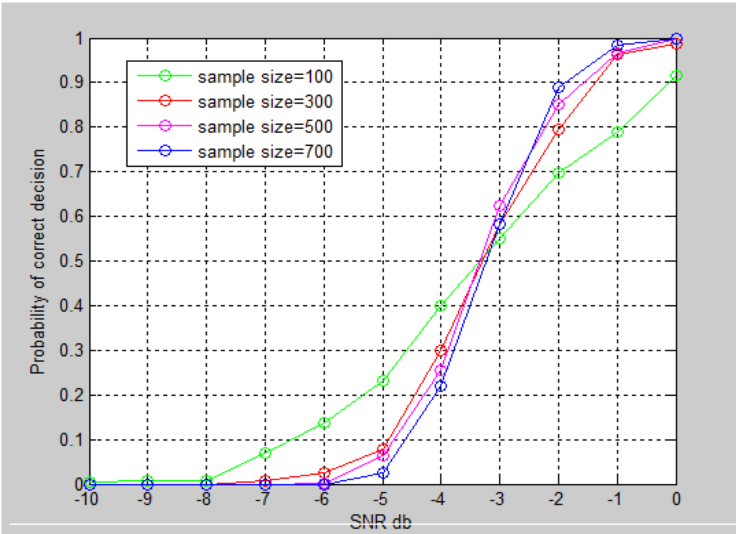

Figure 5 :Performance of ML –Classifier with the different sample size of QAM signals

VI-CONCLUSION

In this paper we propose an maximum likelihood algorithms of modified method of moments based modulation classification in digital communication. This paper overcomes the computation- intensive and time consuming process in the prior art .in contrast with multiple multiplication, addition involved in the likelihood function our method gives a satisfactory performance .these method require reasonable SNR to distinguish signal points especially when the no of signal points increase. And also we compared theoretical performance result with the simulation results that were obtained of actual classification, using randomly generated data.

References

[1] A. Swami and B. M. Sadler, "Hierarchical digital modulation classification using cumulants," *IEEE Trans. Commun.*, vol. 48, pp. 416-429, Mar. 2000.

[2] S. S. Soliman and S.-Z. Hsue, "Signal classification using statistical moments," *IEEE Trans. Commun.*, vol. 40, pp. 908-916, May 1992.

[3] A. K. Nandi and E. E. Azzouz, "Algorithms for automatic modulation recognition of communication signals," *IEEE Trans. Commun.*, vol. 46, pp. 431-436, Apr. 1998.

[4] W. Wei and J. M. Mendel, "Maximum-likelihood classification for digital amplitude-phase modulations," *IEEE Trans. Commun.*, vol. 48, pp. 189-193, Feb. 2000.

[5] C.-Y. Huan and A. Polydoros, "Likelihood methods for MPSK modulation classification," *IEEE Trans. Commun.*, vol. 43, pp. 1493-1504, Feb.-Mar.-Apr. 1995.

[6] Y. Yang and C.-H. Liu, "An asymptotic optimal algorithm for modulation classification," *IEEE Commun. Lett.*, vol. 2, pp. 117-119, May 1998.

[7] Y. Yang, C.-H. Liu, and T.-W. Soong, "A log-likelihood function-based algorithm for QAM signaclassification," *Signal Process.*, vol. 70, no. 1, pp. 61-71, Oct. 1998.

[8] H.-C. Wu, M. Saquib, and Z. Yun, "Novel automatic modulation classification using cumulant features for communications via multipath channels," *IEEE Trans. Wireless Commun.*, vol. 7, no. 8, pp. 3098-3105, Aug. 2008.

[9] F. Hameed, O. A. Dobre, and D. C. Popescu, "On the likelihood-based approach to modulation classification," *IEEE Trans. Wireless Commun.*, vol. 8, no. 12, pp. 5884-5892, Dec. 2009.

[10]Marcos Alvarez-Diaz and Roberto Lopez-Valcarce, "*Diamond contour-based phase recovery for (cross)-QAM constellation*" IEEE ©2005

.[11] O. A. Dobre, Y. Bar-Ness, and W. Su, "Robust QAM modulation classification algorithm using cyclic cumulants," in *Proc. IEEE WirelessCommun. Netw. Conf. 2004*, pp. 745-748.