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A REVIEW PAPER OF PERFORMANCE ASSESSMENT OF UWB-IR CLASSIFICATION

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ABSTRACT

Ultra Wideband Technology for commercial communication application is a recent innovation. The short range remote frameworks have as of late picked up a ton of regard for give interactive media correspondence and to run fast applications around a client driven idea in purported Wireless Personal Area Network (WPAN). UWB innovation presents itself as a decent possibility for the physical layer of WPAN. In this theory, a similar execution examination of the immediate succession spread range (DS-SS) for Pulse Position Modulation (PPM) and Pulse Amplitude Modulation (PAM) plans completed. The simulation results show that the bit error rate (BER) performance of the DS-SS PAM outperforms the DS-SS PPM systems. Further, study is carried out for selection of transmission pulse to meet the FCC specified frequency mask for indoor applications. The work is extended to cover the link budget analysis for UWB systems also.

The present work can be stretched out in future to cover the reasonable channel models for different applications, for example, sensor systems, WPAN and multipath and so on. Channel coding can likewise be a promising exploration heading.

KEYWORD:- USB, IR,

INTRODUCTION

Wireless Sensor Networks can be defined as systems composed of several autonomous nodes linked together by a dedicated wireless link [1]. The nodes architecture may include a microprocessor, several sensor and actuator modules and also a radio communication module on a single board. WSNs support a large range of applications: observing, neighborhood, manufacturing plant and house robotization and strategic applications [1-3]. The contextual investigation exhibited in this paper concentrates a neighborhood framework. It is a sort of remote recognition and ID application, in which sensor hubs are thickly scattered in the ensured zone to identify or sense interruption occasions, created by gatecrasher hubs nearness in their region, with a specific end goal to report it to a base station for examination. This can be utilized to fortify country or military troop's security in atactical application. The intrinsic constraints when setting up such systems are power efficiency, reliability, latency, simplicity, and small size [1-3]. IR-UWB is a good candidate to satisfy the mentioned constraints because of its interesting characteristics which are low radiated power, simple circuitry, localization ability, high multipath resolution and multiuser access capabilities using Time Hopping (TH) [4-5].

The goal of this paper is to analyze and propose an efficient WSN architecture based on IR-UWB and validate it using engineering simulation. As an alternative MACPHY, layer for 802.15.4a based WSN, several IR-UWB MAC-PHY models have been proposed [6-11]. These models can be separated into two classes: the first demands the PHY layer portrayal [6-8]. The second one incorporates this portrayal into the system test system [9-12]. None of them uses the genuine heartbeat engendering delay.Instead, they use a uniformly distributed random value to approximate it. This can be tolerated for the first type of models as they aim to provide a Bit Error Rate versus Signal and Interference to Noise Ratio (BER/SINR) depending on the number of active users. However, when modeling at the network simulator, such approximation can be avoided, as the pulse propagation delay and the number of active users is available.

In reality, the second sort of model does not totally meet the WSN reenactment necessities as it does exclude detecting and sensor channel models. This paper introduces an outline of another created recreation stage for IR-UWB that considers the past said angles. It likewise displays a thorough execution assessment of WSNs that has been directed utilizing this stage. The performance evaluation compares distributed MAC protocol for IR-UWB to 802.15.4 Uncoordinated Access. The network performance is evaluated using a detection and identification application and also Constant Bit Rate (CBR) traffic. CBR is included for comparison purposes as it is mainly the used model to simulate WSN traffic.

The remainder of this paper will be organized as follows. Section 2 gives an overview of the developed simulation platform. Section 3 presents the performance evaluation scenario and their numerical analysis results analysis and finally Section 4 concludes.

SIMULATION PLATFORM OVERVIEW

We built up a WSN test system in light of IR-UWB in our past work [13]. The stage advancement depends on an equipment model [5]. It for the most part concentrates on the IR-UWB PHY and MAC layer exactness displaying. The PHY layer conduct is displayed by considering the beat impact as per the beat engendering delay. Opened and UnSlotted MAC conventions for IR-UWB are demonstrated. A remote location and ID application is additionally included.

Physical Layer Model

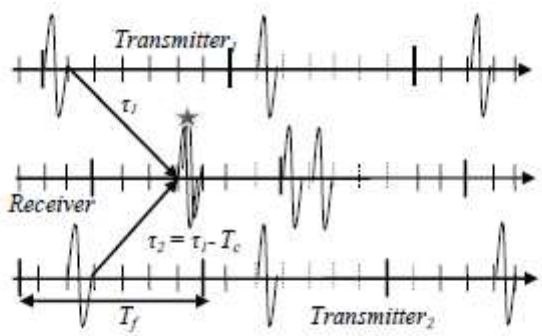

Figure 1: Collision illustration

IR-UWB signals are transmitted in form of very short pulses with low duty cycle (figure 1). The medium is divided into frames and each frame is shared in Nh chips. The frame and chip duration are Tf and Tc, respectively. The transmitted symbol can be repeated following a pseudo random sequence to avoid catastrophic collision under multiuser access conditions [7-8]. Using the Time Hopping Binary Pulse Amplitude Modulation (THBPAM) scheme for example, the kth user transmitted signal s k (t) tx ( ) can be expressed as [7-8]

$$s_{tx}^{(k)}(t) = \sum_{j=-\infty}^{+\infty} \sqrt{E_{tx}}\, x_{tx}\left(t - j.T_f - c_j^k T_c\right) \qquad (1)$$

where E_{tx} is the transmitted pulse energy; x_{tx} denotes the basic pulse shape and kj c represents the jth component of the pseudo random Time Hopping Sequence. The re ceived signal r(t) when only one user is present can be expressed as

$$r(t) = A.S_{tx}(t - \tau) + n(t) \qquad (2)$$

$$r(t) = \sum_{j=-\infty}^{+\infty} A.\sqrt{E_{tx}}.x_{tx}\left(t - j.T_f - c_j^k.T_c - \tau\right) + n(t) \qquad (3)$$

where represents the pulse propagation delay and n(t) is Additive White Gaussian Noise (AWGN) with 2 0 N power density and A represents the attenuation the signal experiences during propagation [7-8]. It depends on the considered channel model in terms of path loss, multipath, shadowing. In a multi user scenario where Nu users are active, the received signal is expressed as

$$r(t) = \sum_{k=1}^{k=N_u} A_k.S_{tx}(t - \tau_k) + n(t) \qquad (4)$$

$$r(t) = A_1.S_{tx}(t - \tau_1) + \sum^{N_u} A_k.S_{tx}(t - \tau_k) + n(t) \qquad (5)$$

where k τ represents the delay associated to the propagation and asynchronism between clocks [7-8]. Ak represents the attenuation of the kth user's signal (k=1 represents the signal of the user interest). This formulation can be used to characterize the TH-IR-UWB PHY layer in a multi user scenario and directly reports to the network simulator [9-12]; however the used propagation delay does not represent the real propagation delay for the real deployment configuration. The used Bit Error Rate (BER) versus the Signal to Interference and Noise Ratio (SINR) is also based on a perfect power control assumption which is not always realistic.

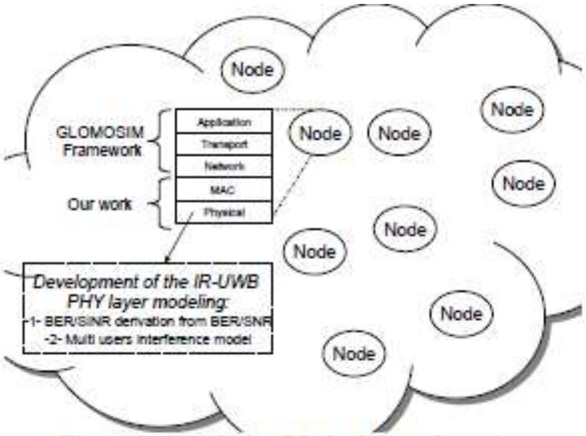

Figure 2: Simulation Methodology Overview

Instead of characterizing BER versus SINR of concurrent transmissions out of the network simulator in a multi user scenario and report it on the network simulator,

our model is based on a two steps characterization process. We first perform an extensive Matlab/Simulink© simulation to obtain the relationship between the BER and the SNR: E N0 b in a single user scenario. The BER versus SNR for IR-UWB can also be derived from point to
point link measurement in the targeted environment.

The multi client impedance portrayal is accounted for to the system test system PHY layer show for more exactness. This constitutes the second portrayal venture in our model (figure 2). In this progression we demonstrate the beat impedance as indicated by the beats' genuine proliferation delay, amid the simultaneous transmission, rather than utilizing Gaussian estimate to copy the multi client obstruction. In reality, Gaussian guess to assess multi client impedance has been turned out to be doubtful [8]. Moreover, our new scheme avoids an a priori assumption about the propagation delay k τ , the number of active users Nu and the perfect power control ability as they are available during the simulation. The propagation delay is computed according to the node position, the pulse velocity and the occupied bandwidth [13]. The number of active users depends on the number of concurrent transmission being performed. The received power is evaluated according to the used channel model (Free Space, Rice or Rayleigh channel model).

The multiuser get to obstruction is figured and added to the collector foundation commotion n(t) on a chip for each chip premise. This method beats the model proposed in [9] regarding precision. For sure, in [9], the beat engendering postponement of simultaneous transmission utilizing the same or diverse THS is primarily demonstrated at the main portrayal organize utilizing a Gaussian estimation [8]. Note that the reception THS at a particular receiver depends on its local view of the medium frame structure (Figure 1). So it may vary depending on the node position and the central frequency of the occupied bandwidth. The jth component of the reception time hopping sequenceof the kth user at a particular receiver can be expressed as

$$\rho_j^k = \left(T_c c_j^k + \tau_k\right) \bmod T_f . \qquad (6)$$

The reception THSs are computed and stored in an interference matrix M (Figure 3). We use an interference vector S to store the SINR of the signal pulses of the user of interest. For each received pulse, the SINR is dynamically updated. The pulses that interfere with the user of interest (user1) are the reception sequence jth elements defined by the interfering matrix content such as:

$$\left(T_c . c_j^1 + \tau_1\right) \bmod T_f = \left(T_c . c_j^k + \tau_k\right) \bmod T_f . \qquad (7)$$

$$\Leftrightarrow \quad \rho_j^1 = \rho_j^k \qquad (8)$$

Doing the parallel between the previous equations and the received power k P of the concurrent reception, the received signal for the user of interest can be expressed as

$$P_{rx} = P_1 + \sum_{k=2}^{N_u} \left(\bar{P}_k + \frac{N_0}{2} \right), \qquad (9)$$

Where −k P represents the received power of pulses located in the same frame.

$$\bar{P}_k = \begin{Bmatrix} P_k, \mathit{if}\ \rho_j^1 = \rho_j^k \\ 0, \mathit{otherwise} \end{Bmatrix} \qquad (10)$$

So the SINR vector S can be obtained as follow where the Jth component is defined as:

$$S_j = \frac{P_1}{\frac{N_0}{2} + \sum_{k=2}^{N_u} \bar{P}_k}. \qquad (11)$$

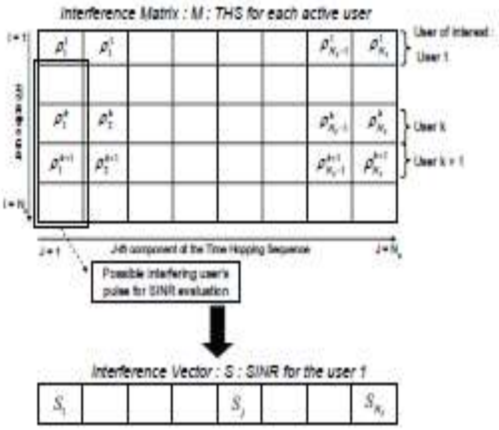

Figure 3: Multi user interference illustration using an interference matrix

This model is based on a single user reception model. However, multi user reception is possible once the preambles are well acquired, which means that the reception THS do not interfere. In this particular case the SINR vector S has to be replaced by an SINR matrix as we are interested in decoding every receiving signal.

The presented methodology is generic, thus it can be used for any multiuser access scheme: Frequency Hopping Spread Spectrum (FHSS) as well as Direct Sequence Spread Spectrum (DSSS) for example.

MAC layer model

We modeled distributed Medium Access Control protocols for IR-UWB [14]: UnSlotted and Slotted MAC model. These are simple ALOHA [3] [15] like protocols with parameterized reliability and slot size. Their performances are evaluated and presented in the Section 3.

Sensor and sensing channel model

Definite demonstrating of the sensor gadget is a key element to acquire an exact WSN reenactment system, as it affects the system execution [16-17]. Our model depends on repairman wave spread. To set it up, we initially describe the sensor gadget and detecting channel by considering their critical parameters: examining rate, detecting range, missed identification rate. We utilize this portrayal to emulate the sensor hub conduct on the system test system.

- The sensing range is modeled using a probabilistic detection range instead of full disc coverage.
- The signal propagation is modeled by a two ray ground reflection path loss and a Ricean fading multipath channel model.
- Missed detections are modeled using adjustable parameters.

The guideline is abridged as takes after: The focused on hubs occasionally create a flag at the testing rate of the sensor gadget. This flag is detected by the sensor hub. As indicated by its affectability, it distinguishes or not the nearness of an interloper.

The two defined thresholds represent the device sensitivity and its detection threshold for correct detection (figure 4). Furthermore, the signal generated by two or more targeted nodes may collide at the sensor device input, thus leading to missed detection. The presence of an intruder or a targeted node may not always be notified by the sensor device because of the additional attenuation due to multipath losses, thus leading to missed detection.

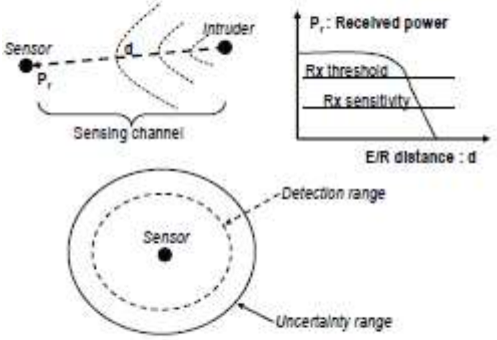

Figure 4: Sensor and sensing channel

This generic method can be used to represent many kind of sensor device behavior, after adjusting the mentioned parameters. An example of a sensor device which can be modeled following the mentioned technique is a binary acoustic sensor present in the Mica Mote hardware. This kind of device provides one bit information regarding the presence or absence of an intruder node in its vicinity without 100% reliability [18].

USB RADIO LINK AND SIMULATION PARAMETERS

UWB radio signs must, on a basic level, exist together with other radio signs. Conceivable impedance from and onto different interchanges frameworks must be contained inside controlled qualities that demonstrate the greatest bearable energy to be available noticeable all around interface at any given recurrence, as set by emanation covers. In this section, we will initially break down how to peruse and apply an emanation veil, and second, we will present the strategy for playing out a connection spending plan, that is, we will decide the greatest separation of proliferation at a given information rate under a most extreme likelihood of mistake requirement for the UWB indicate point interface.

Power Limit and Emission Marks

The power limitation set by emission masks is on the effective radiated power, that is the Effective Isotropic Radiated Power (EIRP) for a given range of operating frequencies, and is given by the product of available power of the transmitter P_{TX}, which is the maximum power that the transmitter can transfer to the transmitting antenna and the gain of the transmitter antenna G_{AT}.

$$EIRP=P_{TX}G_{AT} \tag{12}$$

Link Budget

The PSD limitation defined by emission masks determines the maximum allowed transmitted power. Given the allowed power, we will now evaluate, under rather simplified hypotheses, the maximum distance over which propagation can occur when a predetermined probability of error must be guaranteed at the receiver, at a given data rate. Decision at the receiver is based on the observation of a received energy E over a finite time interval, which is composed of mainly two terms: a signal term E_r and a noise term E_{noise}. The noise term may include several independent noise sources such as thermal noise, multi-user interference, and so on, that is:

$$E = E_r + \sum_{i=1}^{N} E_i = E_r + E_{noise} \tag{13}$$

Table 3.1 Simulation Parameters

Specification	Values
Sampling frequency	50e9
Average pulse repetition period	2e-9
Transmitting antenna gain	1
Receiving antenna gain	1
System margin	5 rdB
Order of the derivative	5
Noise figure	7 dB

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THE UWB CHANNEL AND RECEIVER

This chapter analyzes the signal at the receiver, that is, after propagation over the radio channel, as shown in fig(4.1).

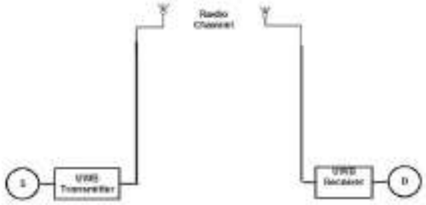

Figure 5: System model for UWB communication

The motivation behind this part is to research how the above models decipher on account of correspondences frameworks utilizing IR-UWB. IR-UWB consolidates impossible to miss highlights that should be considered for a thorough examination of framework plan. We initially take consummate synchronization amongst transmitter and beneficiary, and continue to give a point by point examination of collector structures for various IR-UWB balance groups, and specifically DS-UWB. The IR-UWB transmitted flag is in a perfect world made out of a grouping of heartbeats that don't cover in time. Each heartbeat is bound to a particular time interim, and the beat itself has limited span. While ISI among heartbeats having a place with a similar transmission is in a perfect world missing in the transmitted flag, it won't not be so after the flag has gone through a genuine channel. Pulses might in fact be delayed by different amounts, and replicas of pulses due to multiple paths might cause ISI. Moreover, in the case of the presence of several users transmitting over the same channel, pulses originating in other transmission links may collide with pulses belonging to a reference transmission, giving rise to an interference noise called Multi-user interference (MUI).

The Isolated Pulse Receiver for Binary Orthogonal PPM

In binary orthogonal PPM, M = 2 and the two possible transmitted signals are:

$$s_m(t) = \begin{cases} \sqrt{E_{TX}}\, p_0(t) & for \;\; b = 0. \\ \sqrt{E_{TX}}\, p_1(t) & for \;\; b = 1 \end{cases} \tag{14}$$

where $p_o(t)$ is the energy-normalized waveform of the basic pulse, E_{TX} is the transmitted energy per pulse, and " is the time shift introduced by PPM. If ε is larger than pulse duration T_M, the set of orthonormal functions can be formed by $p_0(t)$ and $p_1(t)$, that is:

$$sm(t)=sm_0p_0(t)+sm_1p_1(t) \qquad m=0,1$$

$$where \quad \begin{cases} s_{00} = \sqrt{E_{TX}} \\ s_{01} \quad = 0 \\ s_{10} \quad = 0 \\ s_{11} = \sqrt{E_{TX}} \end{cases} \tag{15}$$

The optimum receiver scheme for the above signal format is formed by a bank of two correlators,

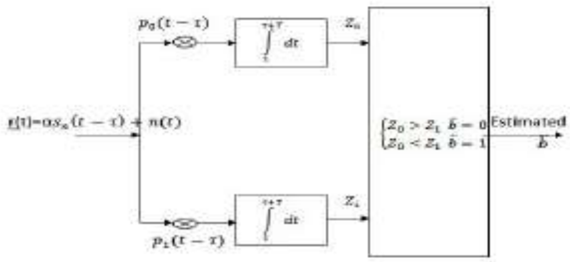

Figure 6: Optimum receiver for 2PPM.

The Isolated Pulse Receiver for Orthogonal M-ary PPM

The case of M-ary PPM can be considered an extension of binary PPM. The ε value is assumed to be larger than pulse duration T_M. The structure of optimum receiver is shown in fig (4.5), and the decision variables at the output of the signal correlator are

$$\begin{cases} Z_0 = \alpha s_{m0} + n_0 \\ \vdots \\ Z_{M-1} = \alpha s_{m(M-1)} + n_{M-1} \end{cases} \tag{16}$$

$$Where s_{mk} = \sqrt{E}_{TX} \int_0^{T_s} p_0(t-m\varepsilon) p_0(t-k\varepsilon) dt$$

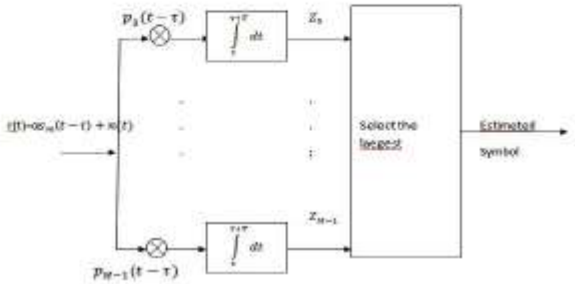

Figure 7: Optimum receiver for M-PPM.

Simulation Parameters

The parameters used to evaluate the performance of DS-PPM and PAM .

Table 4.1 Simulation Parameters

Specification	Values
Sampling frequency	50e9
Number of bits	10000
Number of pulses	10000
Gamma	2
distance	10m

SIMULATION RESULT

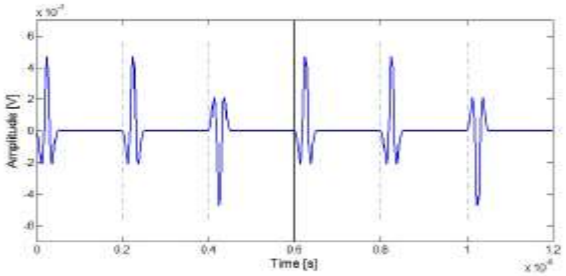

Figure 8: Envelope of received signal

Above Figure shows the envelop of received signal after 10 meters propagation over the free space.

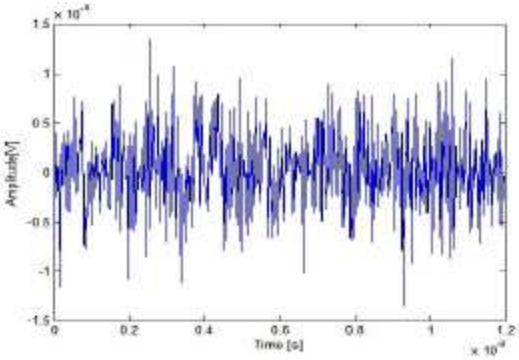

Figure 9: Received Signal rx

Above Figure shows that the effect of noise (Eb/N0 = 0dB) on the received signal.

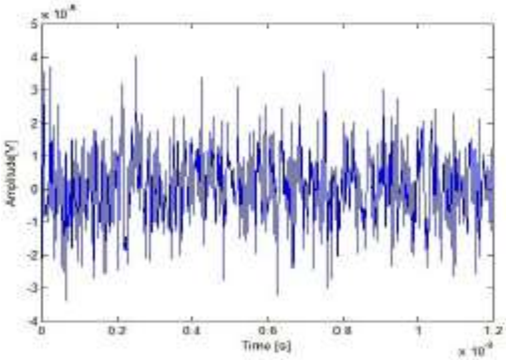

Figure 10: Effect of noise (Eb/N0 = 10dB) at receiver

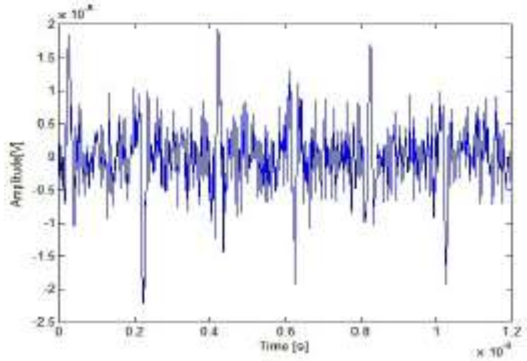

Figure 11: Effect of noise (Eb/N0 = 15dB) at receiver.

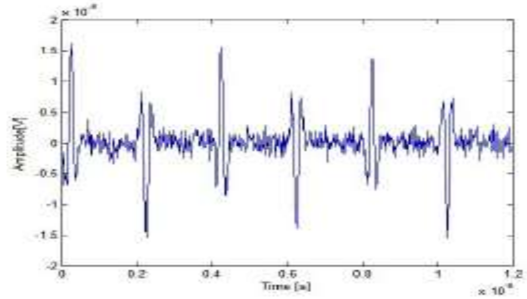

Figure 12: Effect of noise (Eb/N0 = 20dB) at receiver

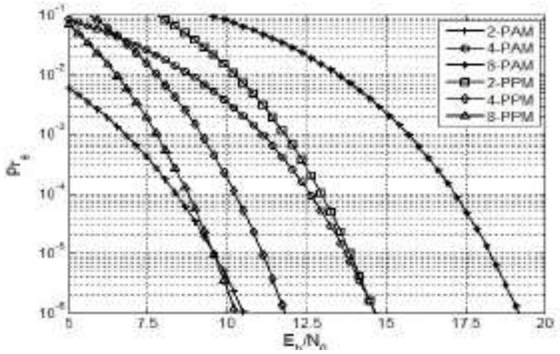

Figure 13: probability of symbol error for M-ary PAM and PPM.

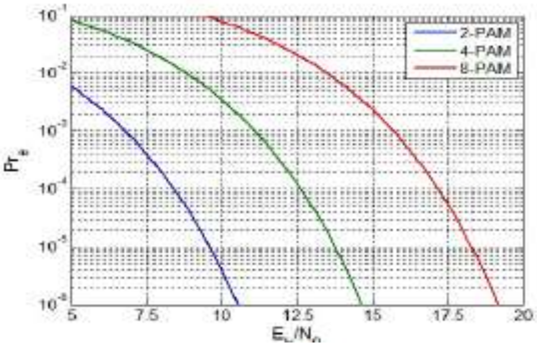

Figure 14: Probability of error for M-ary PAM.

CONCLUSION

We have figured the separation between transmitter - recipient and information rate for DS-PAM and DS-PPM framework, and in section 4 we have calculayed the likelihood of mistake for DS-PAM and DS-PPM framework. It is demonstrated that outcome got utilizing multipath free AWGN channel.

Our comparison results of the presence of Direct-Sequence UWB system for the multipath free AWGN channel,as measured by the probability of error, shows that PAM systems outperforms the PPM systems for all values of SNR. In addition our simulation results show that the system using fifth order pulse performance better than the lower order pulse used system. so pulse selection in UWB is important from the probability of error point of view. UWB frameworks have been focused at High information rate applications over short separations, and in addition Low information rate applications over longer separations. Drive radio based frameworks can exchange information rate for connection separations. UWB innovation is appropriate to sensor arrange applications, with its one of a kind properties of low intricacy, minimal effort, and low power utilization . Additionally, because of the fine time . The low-rate transmission, consolidated with precise area following capacities.

REFERENCES

1. F. Javier Lopez-Martinez, Eduardo Martos-Naya, Jose F. Paris, and Unai Fernandez-Plazaola, "Higher Order Statistics of Sampled Fading Channels With Applications",IEEE Transactions on Vehicular Technology, vol. 61,pp.3342-3346,issue 7, September 2012.
2. Theodore S. Rappaport,Wireless Communications-Principles and Practice, 2ndEd. Prentice Hall, 2000
3. JIA Xiangdong, YANG Longxiang, ZHU Hongbo, "Average Level Crossing Rate and Fading Duration of Multiuser Single Relay Cooperation Wireless Uplinks", IEEE communication,china,vol.10,issue 4,pp.135-143, 2013.
4. Xiangdong Jia, Hongbo Zhu, Longxiang Yang,Second-order statistics of multiuser relay cooperation systems over Nakagami-m fading channels,International Journal of Communication Systems,Wiley, 2013.
5. Khairi Ashour Hamdi, "Analysis of OFDM over Nakagami-m Fading with Nonuniform Phase Distributions", IEEE Transactions on Wireless Communication, vol. 11,pp.488-492 no. 2, February 2012.
6. Yubo Li, Student, Qinye Yin, Li Sun, , Hongyang Chen, and Hui-Ming Wang, "A Channel Quality Metric in Opportunistic Selection With Outdated CSI Over 51BIBLIOGRAPHY Nakagami-m Fading Channels", IEEE Transactions on Vehicular Technology, vol. 61,issue 3,pp.1427-1432, March 2012.
7. Natalia Y. Ermolova and Olav Tirkkonen, "Multivariate _ − µ Fading Distribution with Constant Correlation Model",Communication letters,IEEE,vol.16,issue 4,pp.454-457,2012.
8. Guilherme Silveira Rabelo, Michel Daoud Yacoub and Rausley Adriano Amaral de Souza, "On the Multivariate _ − µ Distribution: New Exact Analytical Formulations", IEEE Transactions on Vehicular Technology vol. 60,pp.4063-4070,no.8 ,October 2011.
9. Norman C. Beaulieu and Kasun T. Hemachandra, "Novel Simple Representations for Gaussian Class Multivariate Distributions with Generalized Correlation", IEEE Transactions on Information Theory,vol 57,no.12,pp.8072-8083,2011.
10. Norman C. Beaulieu and Kasun T. Hemachandra, "Novel Representations for the Bivariate Rician Distribution", IEEE Communications Society,vol.59,issue 11,pp.2951-2954, 2011.
11. Ying Yang, Xiaohui Chen, Wenxiang Dong, Weidong Wang,A general approach to generate Rayleigh fading simulators with correct statistical properties, Wireless Communications and Mobile Computing,Wiley,2011.
12. F. Ramos-Alarcon, V. Kontorovich and M. Lara, "Outage Probability in Nakagami Channels Using Fade Duration Distribution Approximate Results", IEEE Transactions on Communications,vol.58,no.4,pp.1009-1013,April 2010.
13. Daniel Benevides da Costa, JoseCandido Silveira Santos FilhoMiche, Daoud Yacoub and Gustavo Fraidenraich, "Second-Order Statistics of Îu-Î¼ Fading 52 BIBLIOGRAPHY Channels: Theory and Applications",IEEE communication letters,vol.7,pp.819- 824,March 2008.
14. R. A. A. de Souza and M. D. Yacoub, "Bivariate Nakagami-m distribution with arbitrary correlation and fading parameters", IEEE Transanctions Wireless Communication. vol. 7, pp. 5227-5232, Dec. 2008
15. Michel Daoud Yacoub,"The _ − µ Distribution: A Physical Fading Model for the Stacy Distribution", IEEE Transactions on Vehicular Technology,vol.56,no.1,pp.27-34,Jan 2007
16. Lin Yang and Mohamed-Slim Alouini, "Level Crossing Rate over Multiple Independent Random Processes: An Extension of the Applicability of the Rice Formula", IEEE Transactions on Wireless Communications,Vol.6,Issue 12, 2007.

17. Hana Popovic, Dimitrije Stefanovic, Aleksandra Mitic, Ivan Stefanovic, Dusan Stefanovic, "Some Statistical Characteristics of Nakagami-m Distribution",TELSIKS IEEE,pp.509-512,Sep 2007.
18. Da Costa, D.B., Filho, J.C.S.S., Yacoub, M.D., Fraidenraich, G., "Crossing rates and fade durations for diversity-combining schemes over _ − μ fading channels", IEEE Transactions on Wireless Communications,vol. 6, issue 12,pp.4263-4267,Dec 2007.
19. Neji Youssef, Member, Cheng-Xiang Wang, and Matthias Patzold, "A Study on the Second Order Statistics of Nakagami-Hoyt Mobile Fading Channels", IEEE Transactions on Vehicular Technology,vol 54,issue 4,pp.1259-1265,Jul 2005.
20. Gustavo Fraidenraich, Michel D. Yacoub, and Jose Candido S. Santos Filho, "Second-Order Statistics of Maximal-Ratio and Equal-Gain Combining in Weibull Fading", IEEE Communication Letters,vol.9,issue 6, pp.499-501,Jun 2005.
21. Norman C. Beaulieu, Fellow and Xiaofei Dong, "Level Crossing Rate and Average Fade Duration of MRC and EGC Diversity in Ricean Fading", IEEE Transactions Communication,vol 51,issue 5,May 2003.
22. Cyril-Daniel Iskander and P. Takis Mathiopoulos, "Analytical Level Crossing Rates and Average Fade Durations for Diversity Techniques in Nakagami Fading Channels", IEEE Transactions on Communications,vol.50,no.8,pp.1301-1309,Aug 2002.
23. Abdi A., Kaveh Mostafa, "Level crossing rate in terms of the characteristic function a new approach for calculating the fading rate in diversity systems", IEEE Transactions on Communication, vol. 50, no. 9, 2002.