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PERFORMANCE ANALYSIS OF MODULATION SCHEMES FOR WIRELESS SENSOR NETWORKS

Ranjan Kumar Mahapatra, Sairupa, Saritha and Ravi Prasad

Madanapalle institute of technology and science
Email ID: sairuparupa395@gmail.com

ABSTRACT

Wireless sensors networks transmit and receive data and pass this information to base station as well as to the user for necessary action. The network may be deployed in re- mote places where human intervention is not possible. Due to the small size of the sensor nodes, energy consumption may be one of the major issues for the increased lifetime of the sen- sor network. To overcome such issues, the modulation tech- nique which provides acceptable Bit Error Rate (BER) is de- sirable. A performance analysis of modulation schemes with consideration of BER and ECC through a Gaussian channel (AWGN) is the primary focus of the presented work. The anal- ysis of result obtained for BER of PSK (0.092), QAM(0.099) and OQPSK(0.091), shows that OQPSK can be better modula- tion scheme in wireless sensor network.

Keywords *- Modulation schemes, Bit Error Rate, Wireless Sensor Networks*

1. INTRODUCTION

A wireless sensor network (WSN) is any sort of computer network that uses wireless data connections to plug networknodes. A WSN consists of a set of connected tiny sensor nodes, which communicate with each other and exchange information and data. These nodes obtain information on the environment such as temperature, pressure, humidity orpollutant, and send this information to a base station. It is anetwork responsible for collecting, processing and distribut-ing wireless data to the intended database storage center. Allthe nodes communicate wirelessly in WSN and follows var-ious routing protocols. Wireless sensor networks (WSNs) are widely used in various application types such as Medical treatment, battle field, Industrial monitoring and threat de- tection. Several existing modulation schemes such as phasemodulation, frequency modulation, amplitude modulation which support the sensor network in maintaining the con- nectivity for longer time period. Therefore, to provide betternetwork lifetime, this work mainly aims to provide efficientsolution by finding out appropriate modulation scheme for wireless sensor networks. A wireless sensor network is a group of sensor nodes deployed in a area of interest to gatheruseful information. A self-configuring WSN can be very useful in many civil and military applications for collecting, processing and disseminating wide ranges of complex envi-ronmental data. The WSN technology attacted considerableresearch attention in last few years .Long distance wireless communication can be expensive , interms of both energy and implementation complexity. Wireless sensor networks have characteristics that are different from traditional wire-less networks as here nodes have more severe power constraints, although they may transmit at shorter distances andlower data rates.

Wireless Communication:

Due to the increased demand in sensor nodes, wireless com-munication plays an important role. Wireless communica- tion includes infrastructure based as well as infrastructure less networks. Ad-hoc and sensor network are example of such network which is in demand to be taken care of.

Bit Error Rate:

As the name implies, a Bit Error Rate is defined as the rate at which errors occurs in a transmission system. This can bedirectly translated into the number of errors that can occur in a string of a stated number of bits.

Modulation Techniques:

The basic classification of modulation techniques includes Frequency Shift keying, Phase Shift Keying, Quadrature Amplitude modulation etc. The PSK scheme is mostly usedin wireless communication because the probability of error (Pe) or BER is less as compared to QAM scheme

Existing System:

Adaptive PCA is a dimensionality reduction technique that is commonly used to aggregate data. Because the data gath-ered by the sensor nodes is of such low frequency, networkinterferences have an impact on the quality of the sensed data. In this work, an adaptive PCA technique is used to select the carrier signal based on the type of data, such as whether it is of high or low frequency. The PCA algorithm, which is a principal component analysis technique that se- lects the best data based on a selected component, will be used to modulate the selected data. Two tasks are carried out using the PCA technique. The first goal is to reduce the nodes' energy consumption during data aggregation in the network, and the second goal is to lower the network's bit error rate. The PCA algorithm is made up of two sub- algorithms that execute these two tasks: the event checker and the data accuracy checker algorithm. The data sensed by the sensor nodes must be transmitted to the base station in the event checker procedure. The SVM classifier is usedin the proposed approach to divide the data into two groups.The SVM classifier is proposed for regression, classifica- tion, and general pattern recognition.

CHARACTERISTICS OF WIRELESS SENSOR NETWORK:

1.5.1 Location awareness:

Every node must be aware of their real location along with location information of their neighbour nodes. Data gath- ered mostly rely upon the location of nodes based on dis- tance estimation with prior knowledge of PLE.

1.5.2 Data centric:

Wireless sensor network is data centric because it will re- quest data depending upon certain physical parameters suchas spin, direct diffusion etc.

1.5.3 Infrastructure less:

Every node that is equipped with smart sensor in WSN, communicate with each other without any fixed infrastruc- ture. So, communication overhead becomes less. WSN mainly focuses on sensing environmental data, transferringit to the computational center via the sink node, while in AdHoc based on peer-to-peer applications like data sharing.

1.5.4 Mobility:

Mobility of nodes in wireless sensor network sensor net- works is less. The mobility of the nodes affects the numberof average connected paths, which in turn affect the perfor- mance of the routing algorithm. Due to this type of char- acteristic, they're utilized in occasion monitoring functions like movement detection of video frames etc [6].

1.5.5 Network size:

In wireless sensor network, the nodes are scattered in large geographical area. And the number of nodes in Wireless Sensor Network is greater than ad- hoc network, that is net- work size is more [6]. Purchasing the network cabling and file servers can be expensive. Managing a large network is complicated, requires training and a network manager usu- ally needs to be employed. If the file server breaks down thefiles on the file server become inaccessible

CHALLENGES IN SENSOR NETWORK:

The distance estimation which rely on PLE face numerous demanding situations which include several environmental parameters (such as temperature, humidity, battery voltage etc) change. Furthermore, WSN packages pose unique ne- cessities for distance estimation in phrases of scalability, ro- bustness, and accuracy. The primary layout demanding sit-uations and the factors affecting time synchronization are asfollows:

1.6.1 Physical layer Measurements:

These strategies offer neighbourhood facts in phrases of dis-tance associated with a node. This neighbourhood facts canthen be blended to offer region estimates. Ranging strategies are primarily based totally on message exchanges among nodes with inside the community and corresponding energyor timing measurements. The acquired energy or the timingfacts may be transformed into distance measurement.

1.6.2 Lack of GPS:

GPS is applied for place offerings in numerous embedded structures together with mobiliary phones, navigation struc-tures, or laptops. While GPS gives tremendously correct lo- cation information, it can now no longer be viable for max- imum WSN deployments. Firstly, GPS additives to be had for WSNs are very costly as it requires extra hardware tobe included, exceedingly almost 3 instances the price of a sensor node. Furthermore, GPS operation has an excessive power consumption profile, which can also additionally im-pose extra constraints at the life of a WSN. Furthermore, WSNs are generally static and localization protocols can berequired to run most effective initialization of the network. GPS is mostly inaccessible in indoor environment.

APPLICATIONS:

1.7.1 Forest fire detection:

To detect when a fire has started in forest, network of sensor nodes can be installed. If we implement the nodes with sen-sors measuring of temperature, humidity, and gases can be detected. If the node detects fire, it sends an alarm messageto the base station.

1.7.2 Air pollution monitoring:

Traditional air quality monitoring methods like constructingair quality stations are too expensive. so, solution for this is to use technology based on WSN.

1.7.3 Water quality monitoring:

The parameters used to analyse the water quality are tem- perature and pH. Water quality monitoring involves analysisof water properties in dams, rivers, lakes and oceans.

1.7.4 Landslide detection:

Including WSN in land slide detection system will detect themovements of the lands before and after. All the data that iscollected will predict landslides.

1.7.5 Military applications:

By using WSN we can track enemies, chemical attack de- tection, target detection.

MOTIVATION:

Nowadays wireless communication usage has drastically in-creased. Even though there are many methods for localiza- tion of sensor, we are looking to reduce the disadvantages in other models, and we are looking to get more accurate results by using Path Loss Exponent method with minimumcost and minimum complexity.

2. BER SIMULATION METHOD AND SYSTEM

The performance of the wireless sensor network is deter- mined by BER of the transmission system. Its define how much bits change its state during transmission from trans- mitter to receiver. This change may be due to channel noise,interference, distortion or bit synchronization error.. It can be express by the following manner,

BER =Totalnumberof Error Bits During Transmission/TotalNumber of Transmitted Bits

It determine the reliability of the enter radio transmission system and it represent as fractional value. The value of theBER may be varying by changing the modulation scheme in the system. In the presence of impairment of transmission through electronic circuitry and the propagation medium BER become significant.

3. SELECTION OF ERRORCORRECTION CODE IN WIRELESS SENSOR NETWORK

For every application a maximum bit error rate (BER) is specified to achieve a certain quality of Service (QoS). To maintain the BER within this limit, either the transmitter power can be increased or Error control codes can be used. ECC reduced the required transmitter signal energy due to its coding gain. ECC adds additional bits “redundant bits” and hence more energy is requires for transmitting, encod- ing and decoding of extra bits. Therefore at very small dis- tance (¡10 meters), using ECC is less efficient . But if the distance is more (50-100 meters and above) then using ECCis energy efficient as the coding gain will keep the transmit-ter power low for the same BER . We can design a frame work for design space exploration for selection of error con-trol codes (e.g. Hamming, Goley, Convolutional, BCH, RSCodes) in wireless sensor networks . The choice of a par- ticular error correcting code depends upon type of applica- tion, and other sensor network constraints such as environ- mental conditions, channel fading, distance requirements, number of nodes and type of modulations techniques (e.g. BPSK,QPSK, MPSK, QAM, OQPSK etc) used . In this pa-per, we have considered various error correcting codes per-formance evaluation in terms of their Bit Error rate versus Eb/N0 curves all with using BPSK modulation technique. In The design space exploration we select an error correction code and then depending upon application requirements the candidate configuration is made.

4. LITERATURE REVIEW

Susmita Eswar discovered that the BER in the fading chan-nel in Ricans is lower than Rayleigh’s fading channel in sim-ulation and analysis due to the presence of a view on Ricans.We have found that with increased mobile or Doppler speed, the risk of an inaccuracy increases. The major causes of channel capacity deterioration are dynamically altered mul-tipath and Doppler effects. Nonetheless, in future communi-cations, we would like to establish a generic mobile commu-nication (car apps) model. Based on BER, the AWGN chan-nel, Rayleigh channel, and Rician Fading channel evaluate various digital modulation systems such as PSK and QAM.Rayleigh has the weakest performance of all the channels. The performance of the Rician channel

is inferior to thatof the AWGN channel but superior to that of the Rayleigh fading channel. Through LabVIEW simulations, the faded Rician channel has more BER than the AWGN channeland less than the Rayleigh fading channel. Rajat Lumar Giri investigated the BER performance of Single Input Sin-gle Output (SISO) free space optical systems utilising vari-ous SIM-based modulation techniques with reference to re-ceived average optical irradiance for various connection dis-tances, turbulence strengths, and bit rates. The investigationrevealed that increasing any of the aforementioned factors causes the FSO system's performance to degrade. We found that BPSK-SIM modulation had a higher BER performance.The capacity of BPSK-SIM is shown to deteriorate when turbulence states rise. Furthermore, the APD receiver has been proven to outperform the PIN receiver across the wholerange of analyses reported in this work. Indu Chandran An-alyzed Various modulation schemes over fading channels over the OFDM system. The study and analysis reveals that error rate improves with increasing modulation order over AWGN, Rayleigh and Rician channels. To achieve higher data rate required for a given bandwidth 64-QAM is employed with improved error rate over slow fading chan- nels, when compare to other modulations schemes. The fre-quency selective fading channel undergoes lesser variations as it involves line of sight component than flat fading which involves multipath propagation. Noman Chowdhury, M. A.The /6- QPSK modulation approach has been offered as an improved QPSK modulation technique. The proposed /6- QPSK differs from the standard /4-QPSK. When compared to /4-QPSK, the focusing issue of /6-QPSK has less phase transition. Because /6-QPSK has a smaller phase transition, it produces a smaller envelope variation. As a result, the spectral side lobe power of /6-QPSK is lower than that of

/4-QPSK after non-linear amplification. The performance of our proposed technique was evaluated using a MATLAB simulation in this research. When compared to other QPSK systems, the relative phase transition of /6-QPSK is signifi- cantly reduced . Furthermore, after non-linear amplification, the signal spectrum performance of /6-QPSK is better than that of /4-QPSK (see Figs. 13 and 14). As a result, after non-linear amplification, our proposed /6-QPSK is very ef- ficient in wireless communication for data transmission in terms of less phase transition, less envelope variation, and less spectral side lobes power.

5. RELATED WORK ON WSN

Researchers have explored the sensor node energy with dif-ferent modulation schemes. Chouhan et al. have proposeda framework for energy consumption based design space exploration. Using this framework, the authors have ex- plored various modulations schemes and observed that us- ing modulations saves energy as compared to unmodulateddata transmission. E. Shih, S. Cho, F. S. Lee analyze both transmission time and constellation size optimization for MQAM and MFSK (both coded and uncoded), consideringboth transmission and circuit energy consumption. For bothMQAM and MFSK, it has been shown that optimizing trans- mission time or, equivalently, constellation size, minimizes the total energy used for transmission of information[8].This paper extends the work of by considering more practical scenario; we consider three different modulation types in wireless communications ASK, BPSK, and OQPSK, and find an energy minimization scheme for point-to-point wire-less communications. Among these three modulation types,OQPSK has been a preferable choice for WSNs. Further, this paper is extended to the study of three most widely used modulation schemes in wireless communication sys- tems, i.e. MQAM, MPSK and MFSK.

6. MODULATION TECHNIQUES

In fig.2 the basic classification of modulation techniques isshown in which the three basic binary modulation schemesviz. Amplitude Shift Keying (ASK), frequency Shift Keying(FSK) and Phase Shift Keying (PSK). Fig.3 shows the basicblock diagram of digital communication system for mod-elling and visualising the exact position of Modulator and demodulator circuits in transmitter and receiver of a sensornode. The Quadrature Amplitude modulation contains in- formation in both amplitude and phase of the carrier signal.Digital cable television and cable modem applications use QAM as modulation scheme invariantly. A comparison of various modulation techniques is shown in Table 1.The PSK scheme is mostly used in wireless communication because the probability of error (Pe) or (Bit Error Rate(BER) in dig-ital sense) is less as compared to ASK scheme. in case of PSK the signal to Noise ratio (SNR) is high. The complex- ity of coherent schemes is always high compared to non co-herent schemes. Coherent schemes have less probability of error compared to non coherent schemes under same condi-tions.ASK scheme has lowest noise immunity against noise.PSK is best among all shift keying schemes(overall). Co- herent schemes require less power compared to noncoherent schemes for same probability of error. In Marray signallingwe can use M number of phases (in case of PSK), M numberof frequencies (in case of FSK), M number of amplitudes levels (in case of ASK) for sending digital data. By using M-array signalling scheme we can send data at higher rate at the cost of increased probability of error (Pe).

7. SOFTWARE SPECIFICATIONS AND REQUIREMENTS

MATLAB (version-2019) software is used to estimate the modulation technique. In MATLAB, Bit Error Rate app is used to estimate the performance of modulation schemes, with this parameter Eb/N0 can be estimated.

8. SIMULATION RESULTS

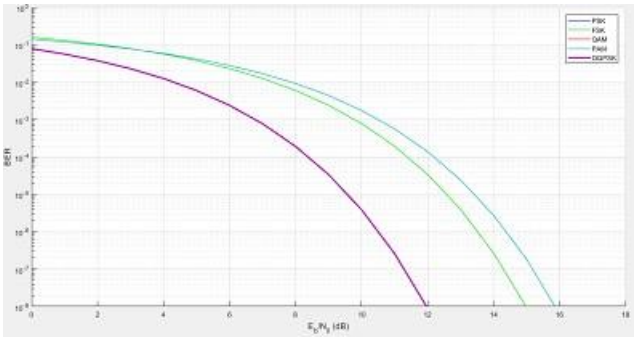

Fig. 1. **Comparison of all modulation schemes in AWGN**

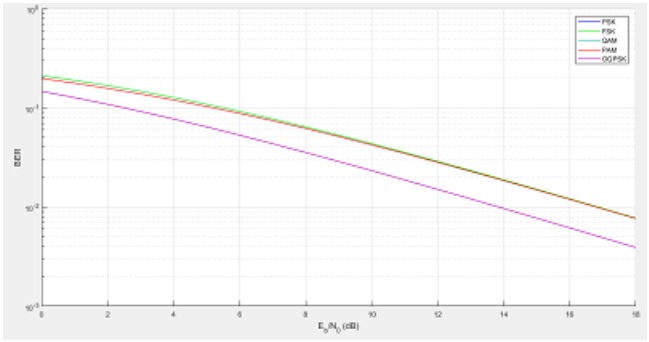

Fig. 2. **Comparison of all modulation schemes in Rician**

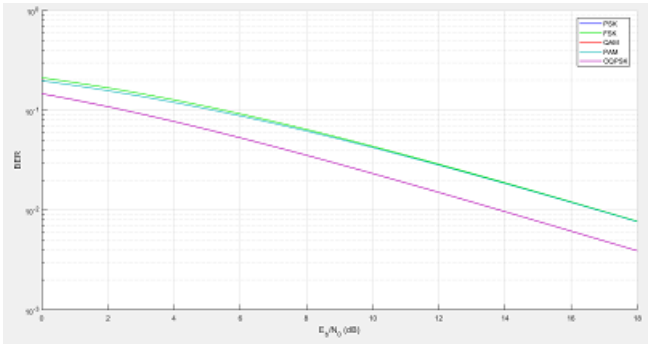

Fig. 3. **Comparison of all modulation schemes in Rayleigh**

8.1. Comparison table

Modulation Scheme	Modulation Order	BER	Eb/N0
PSK	4	0.063	12
FSK	4	0.112	12.1
QAM	4	0.063	12
PAM	4	0.112	15.9
OQPSK	4	0.063	12

Table-2: Comparision of BER of all modulation schemes

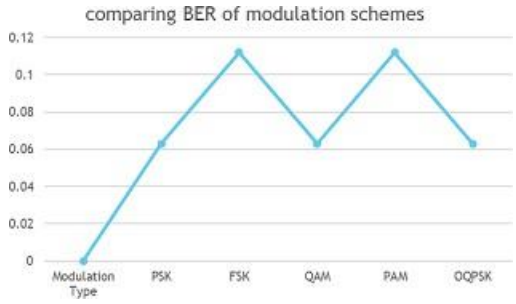

Fig. 4. **From Figure, FSK and PAM are giving high BER values compared to others. PSK, QAM and OQPSK are giving same BER, theoretically conclusion drawn that OQPSK is effective modulation technique**

9. CONCLUSION

The BER result (AWGN)was compared with Rayleigh, Racian for different modulation schemes PSK, FSK, QAM, PAM, OQPSK and the conclusion drawn is OQPSK is the effective modulation scheme for AWGN channel. Compar-ision of all modulation schemes in terms of BER is carried out in Monte Carlo Simulation, and compared results with theoretical calculations. The result obtained by Monte CarloSimulation work shows that QAM, PAM, OQPSK providessame bit error rate as compared to FSK and PSK . With these analysis and comparision with previous results it can be con-cluded that OQPSK behaves well in AWGN channel. Out ofPSK, FSK, QAM, PAM, OQPSK , the OQPSK proves to be best modulation scheme as ASK has high possibility of error. Therefore even if ASK has high possibility of error. Therefore even if energy consumption of ASK is less than OQPSK but due to high sensitivity to noise we reject this modulation scheme and choose OQPSK among the modula-tion schemes.

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