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Performance Evaluation Of BPSK And QPSK Modulation With LDPC Codes

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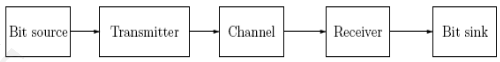
Abstract **: BPSK and QPSK are the digital modulation schemes, QPSK and further$\pi/4D$QPSK are the best suited modulation techniques therefore more emphasize given on QPSK, which specially used in DVB area. A coding and modulation technique is studied where the coded bits of an irregular LDPC are passed directly to a modulator. We evaluate and compare the bit error rate, signal constellations etc. In this paper, we consider a transmission over a Gaussian noise channel. Log Likelihood Ratio (LLR) decoder can be suggested for receiver.**

Index Terms: Differntial Quadrature Phase Shift Keying (DQPSK),Low Density Parity Check Codes(LDPC).

1. Introduction of BPSK/QOSK:

The BPSK and QPSK system considered in this paper, illustrated in Figure(1), consists of a bit source, transmitter, channel, receiver, and a bit sink. The bit source generates a stream of information bits to be transmitted by the transmitter .typically, a random bit generator is employed as a bit source in simulations and this is the case herein as well. The transmitter converts the bits into QPSK symbols and applies optional pulse shaping and up conversion. The output from the transmitter is fed through a channel, which in its simplest form is an AWGN channel. The receiver block takes the output from the channel, estimates timing and phase offset, and demodulates the received QPSK symbols into information bits, which are fed to the bit sink. Typically, in a simulation environment, the bit sink simply counts the number of errors that occurred to gather statistics used for investigating the performance of the system.



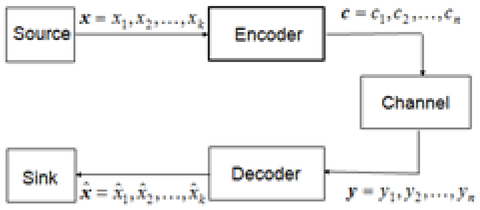
Figure(1)The QPSK Communication System.

1. BPSK is a real-valued constellation with two signal points: c(0) = A and c(1) = -A, where A is a scaling factor. This is shown in Figure 2 (a). The average complex baseband symbol energy is $E_8 = E[c(i)^2] = A^2$.
2. QPSK is a complex constellation with four signal points,

   $c(i) = \sqrt{\mathbf{2}}A \exp\left[j\frac{\pi}{2}\left(i+\frac{1}{2}\right)\right],$

For I = 0, 1,2,3. It is convenient to include the $\sqrt{2}$ factor so that the average symbol energy is $E_s = E[||c(i)||^2] = 2A^2$, double that of BPSK, but with the same energy per transmitted bit as BPSK.[1][2][3][8]

2 Basics of LDPC



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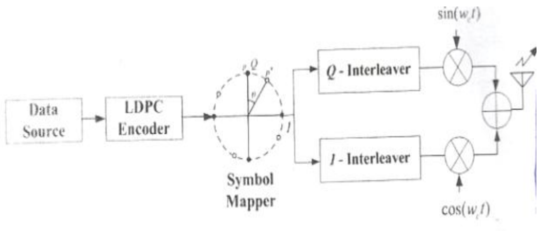
Figure(2),Block diagram of LDPC Encoder/Decoder.

We use the LDPC code to communicate over the noisy channel. LDPC codes form part of a larger family of codes, which are typically referred to as linear block codes.A code is termed a block code, if the original information bit-sequence can be segmented into fixed-length *message blocks*, hereby denoted by u = *u*1, *u*2, . . . , *uK*, each having *K* information digits. This implies that there is 2*K* possible distinct message blocks. For the sake of simplicity, we will here be giving examples for binary LDPC codes, i.e. the codes are associated with the logical symbols/bits of (1, 0). The elements (1, 0) are said to constitute an *alphabet* or a *finite field*, where the latter are typically referred to as Galois fields (GF). Using this terminology, a GF containing *q* elements is denoted by GF(*q*) and correspondingly, the binary GF is represented as GF(2). The LDPC encoder, is then capable of transforming each input message block u according to a predefined set of rules into a distinct *N*-tuple (*N*-bit sequence) z, which is typically referred to as the *codeword*. The codeword length *N*, where *N* > *K*, is then referred to as the *block-length*. Again, there are 2*K* distinct legitimate codewords corresponding to the 2*K* message blocks. This set of the 2*K* codewords is termed as a C(*N*,*K*) linear *block code*. The word *linear* signifies that the modulo-2 sum of any two or more codewords in the code C(*N*,*K*) is another valid codeword. The number of non-zero symbols of a codeword z is called the *weight*, whilst the number of bit-positions in which two codewords differ is termed as the *distance*. For instance, the distance between the codewords z1 = (1101001) and z2 = (0100101) is equal to three. Subsequently, codewords that have a low number of binary ones are referred to as *low-weight* codewords. The *minimum distance* of a linear code, hereby denoted by *d*min, is then determined by the weight of that codeword in the code C(*N*,*K*), which has the minimum weight. The reason for this lies in the fact that the all-zero codeword is always part of a linear code and therefore, if a codeword z*x* has the lowest weight from the 2*K* legitimate codewords, then the distance between z*x* and the all-zero codeword is effectively the minimum distance.[10][11][12][13][14][16]

3. LDPC Encoded QPSK:

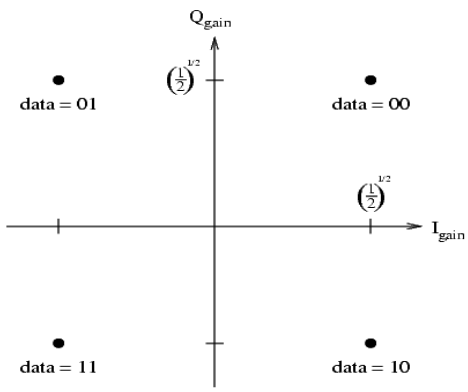


Figure(3) shows a simplified block diagram of a channel coded communication system using linear block codes..[12][13][14][15]

Table 1.Differential Phase Shifts for $\pi/4$ DQPSK using Gray Code:

Information Symbols, $I(k)$ and $Q(k)$	Differential Phase Shift, $\phi(k)$
1 1	$\pi/4$
0 1	$3\pi/4$
0 0	$-3\pi/4$
1 0	$-\pi/4$

4. QPSK Constellation :



Figure(4) ,QPSK Constellations Phasewise

A conventional M-ary phase-shift keying (MPSK) signal constellation is denoted by $S_M = \{ s_k = e^{2\pi}(k/M)j$: k = 0, 1,….., M –

1}, where the energy has been constrained to unity, Clockwise rotation over an angle $_\theta$ (see Figure 2) leads to the constellation.

$$\mathcal{S}_M^{\theta} = \{s_k = e^{(2\pi(k/M)-\theta)j} : k = 0, 1, \ldots, M-1\}. \quad (1)$$

Such a (complex) modulation scheme can be seen as two (real) M- ary pulse amplitude modulations (MPAM s) in parallel - one on the inphase (I channel) and the other on the quadrature channel (Q channel) . For the QPSK and 8 PSK constellations.[6][8][9]

4.1 Separate I and Q Component

It was shown in[2), that by rotating the signal constellation and separately interleaving the I and Q components, an improved performance can be obtained for a QPSK system without effecting its bandwidth efficiency. In case of transmission of N symbols, each taken from the rotated constellation. $S^{\theta}_{M,}$ let the sequence of I components xxxx = (xo,x1 ,……, xN -1)And the sequence of Q components y = (yo, y1,…, yN -1)Be interleaved by the I interleaver n and the Q interleaver Q, respectively, resulting in the sequences x = n(x) = (xo, x1,….,xN – 1) and y = p(y) =(yo, y1,…..,yN – 1). The transmitted waveform for the rotated and interleaved system is given by

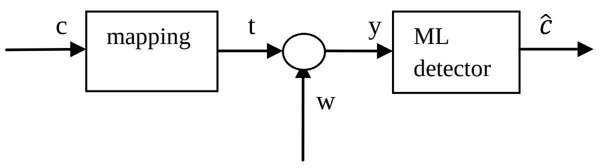
$$+ \sum_{i=0}^{N-1} \tilde{j}\, iP(t - iTs)\sin(2\pi fct).$$

$$s(t) = \sum_{i=0}^{N-1} \tilde{x}\, iP(t - iTs)\cos(2\pi fct)$$

Where

$$p(t) = \begin{cases} 1, & 0 \leq t \leq T_s, \\ 0, & \text{otherwise,} \end{cases}$$

Ts is the is the symbol period and fc is the carrier frequency.



Figure(5),BPSK/QPSK transmission over a Guassian channel

The transceiver for BPSK (QPSK) transmission over a Gaussian channel is shown in figure(5) The code bits $\{c_n | n = 1, \ldots, N\}$ are first mapped on the symbols $\{t_n\}$ ($t_n \in \{-x_0, x_0\}$ for BPSK and $t_n \in \{x_0 (\pm 1 \pm j)\}$ for QPSK). The sequence $\mathbf{t}$ is then transmitted over the Gaussian channel. The channel adds white Gaussian noise w, with uncorrelated real and imaginary parts, each having a variance σ^2, resulting in the sequence $y = \mathbf{t} + w$. Based on the received sequence y, a decision is taken about the transmitted code word. The ML decision rule is given by

$$\hat{c} = \arg\min d^2(y, \mathbf{t}(c))$$

where d^2 (a, b) is the Euclidean distance between the sequences a and b, and $\mathbf{t}(c)$ is the sequence of transmitted data symbols that correspond to the code word c. Hence, he receiver selects the code word that corresponds to the sequence of symbols that is at minimum Euclidean distance of the received sequence y. The bit error rate (BER) is given by

$$BER = \sum_{i,j=1; j\neq i}^{2^k} Pr(\hat{c}_j | c_i) \frac{d_H(b_j, b_i)}{K}$$

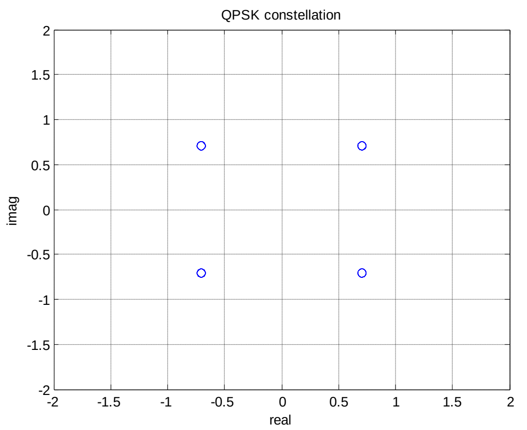
where $Pr(\hat{c}_j | c_i)$ is the probability that the code word c_j is selected at the receiver when the code word c_i is transmitted, $Pr(c_i)$ is the prior probability that the code word c_i is transmitted, $d_H(b_j, b_i)$ is the Hamming distance between the information words b_j and b_i), that correspond to the code words c_j and c_i, respectively, and K is the length of the information word. In the following we assume that all information words, hence all code words, are equiprobable, i.e. $Pr(c_i) = 1/2^K$.[4][5][6][7]

RESULT :

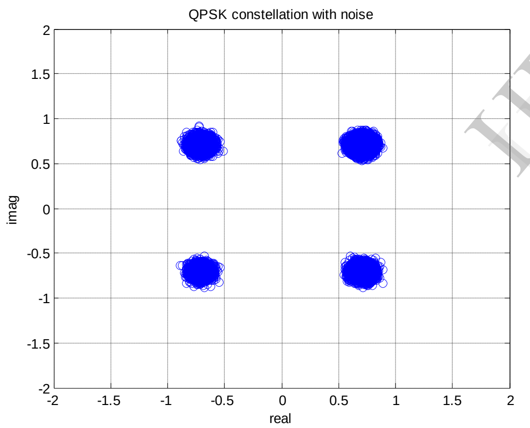
The constellation of BPSK and QPSK discussed theoretically and found that QPSK is far better than BPSK because average symbol energy is double than BPSK and it transmit two bits simultaneously: The results are simulated in Matlab. Figure (5) shows the constellation symbol for various phases' shown in table 1. Figure (6) gives the AWGN over the constellation points and at the last figure (7) shows BER versus Eb/No. curve for theoretical as well as simulated.

CONCLUSION:

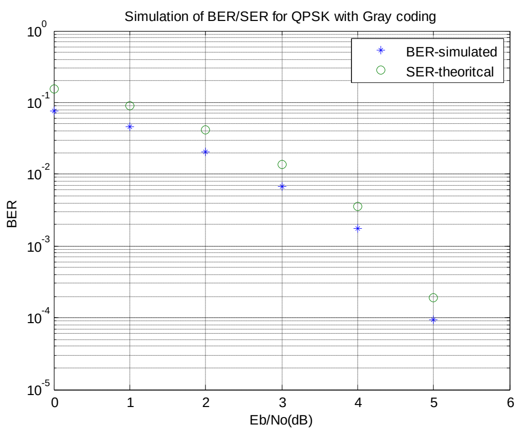
For digital transmission of data QPSK is best suited method and LDPC outperforms than other earlier codes like turbo codes, RS-CC codes.



Figure(6),QPSK Phase constellation Points



Figure(7),AWGN Noise



Figure(8),BER Vs.Eb /No curve

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