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Survey of Different Techniques Used In MIMO-OFDM Communication System

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Abstract: *QAM transfers data by changing some aspect of a carrier signal, in response to a data signal. In the case of QAM, the amplitude of two waves, 90 degrees out-of-phase with each other (in quadrature) is changed to represent the data signal. Amplitude modulating two carriers in quadrature can be equivalently viewed as both amplitude modulating and phase modulating a single carrier. QAM provides higher transmission efficiency by utilizing both amplitude and phase variations. However it requires higher transmission bandwidth due to its equal error protection to transmitted bits. So this may lead to cliff effect. Cliff effect describes sudden loss of digital signal reception. Unlike analog signals, which gradually fade when signal strength decreases, or electromagnetic interference or multipath increases, A digital signal provides data which is either perfect or non-existent at receiving end. Hierarchical QAM divides incoming data stream into two parts i.e. HP(High priority) and LP(Low priority) bits. Here extra protection is provided to high priority or sensitive bits than on lower sensitive bits. The data streams of hierarchical modulation vary in their susceptibility to noise. In other words, the service coverage areas differ in size.This paper surveys the suitability of Hierarchical QAM (HQAM) where non-uniform signal constellation is used to provide different degrees of protection to the significant and non-significant bits in the compressed image data.*

Keywords: *OFDM, QAM, HQAM*

1. INTRODUCTION

Quadrature amplitude modulation (qam) is a big name for a relatively simple technique. For a given channel bandwidth, qam transmits more information as compared to bpsk and qpsk. However, it is more susceptible to noise because the states are closer together so that a lower level of noise is needed to move the signal to a different decision point. Receivers for use with phase or frequency modulation are both able to use limiting amplifiers that are able to remove any amplitude noise and thereby improve the noise reliance. This is not the case with qam. When a phase or frequency modulated signal is amplified in a transmitter, there is no need to use linear amplifiers, whereas when using qam that contains an amplitude component, linearity must be maintained. Hierarchical Quadrature Amplitude Modulation (HQAM) is more spectrally efficient and dc-free modulation scheme. It provides different degree of protection to the transmitted data bits, in which the high priority (HP) data bits are mapped to the most significant bits (MSB) and the low priority (LP) data bits are mapped to the least significant bits (LSB) of the modulation constellation points. Using HQAM will, therefore, result in improved image quality compared with QAM specially at low channel SNR conditions, since the highly sensitive HP data bits are mapped to the MSBs with low bit error rate (BER) in HQAM [1].Now days, there has been an increasing demand for multimedia applications such as transmission of text, data, voice and images from source to destination. For multimedia transmission the main things of concern are bandwidth and high probability of error. So, compression is applied to transmitted data to conserve bandwidth. But, compression technique introduces errors. Another important issue to be considered is degradation of image quality while transmission of image from source to destination. To overcome these problems the author use source coding and channel coding. Source encoder encodes the source image using image compression technique. Channel coding adds redundancy to the coded image. Also most common type of image which affects the noise is salt pepper noise where certain percentage of individual pixels in digital image is randomized into maximum and minimum intensities. This distortion has large effect on critical bits of received signal.

2. IMAGE TRANSMISSION SYSTEM

The essentials of the image transmission system considered here are shown in Fig. 1. The source encoder encodes the source image using appropriate image compression technique. For the protection of coded image in Fig. 1 channel encoder add

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redundancy to the coded image by using appropriate channel coding technique. Modulator modulates the coded image and transmits through wireless channel. QAM is invariably used as the modulation technique [4]. The channel introduces noise and distortion to the transmitted image. The demodulator receives the image data with error and demodulates it. After channel decoding, the coded image is decompressed. There are two major constraints in transmission of images over wireless channels. First there are fluctuations in the channel bandwidth for this reason the image data must be compressed. Second, there is a high probability of channel error for this reason the image data must be protected from errors in order to maintain image quality.

3. EFFECTS OF NOISE AND DISTORTION IN IMAGE TRANSMISSION

The most common type of noise that is encountered in image transmission system is the Salt and pepper noise(special case of impulse noise) [9], where a certain percentage of individual pixels in digital image are randomly digitized into two extreme intensities (maximum and minimum). Faulty memory locations or transmission through erroneous channels can result in the received image being corrupted with this type of noise [8]. The effect of salt and pepper noise on the received image is shown in Fig. 2(a).

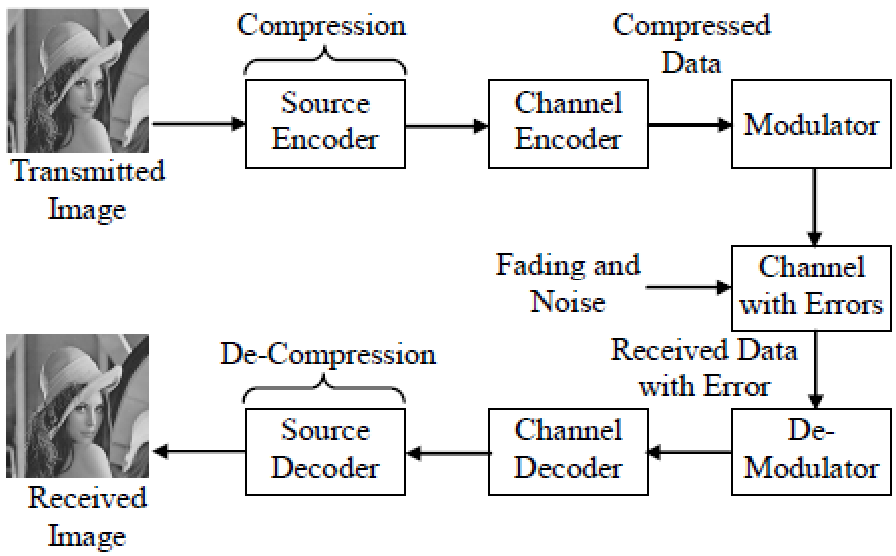


Fig. 1: Model of image transmission system [1].

(a)

(b)

(c)

(d)

Fig. 2 (a) Effects of Salt & pepper noise (b) Effects of error in critical bits(c) Effects of error in sign bit (non-critical bit) (d) Effects of error in refinement bits [1]

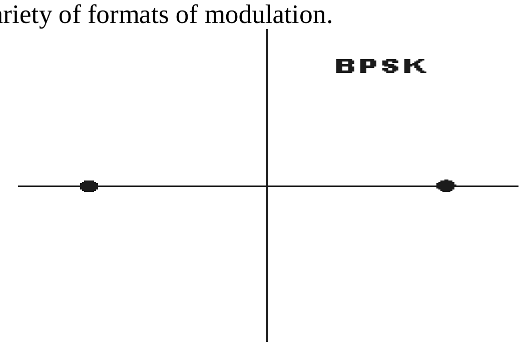
Distortion in images occurs when errors cause local variations in image scale and coordinate location of the image pixels. The distortion is more severe when the errors occur in critical (significant/high priority) bits of the received signal. For errors in non-critical bits (sign bits/low priority bits and refinement bits/low priority bits) the distortion is not that severe. This can be seen from Fig. 3(b), 3(c) and 3(d). Fig. 3(b) corresponds to the case when the errors are in significant bits while Fig. 3(c) and 3(d) result when the error is in sign or refinement bits. Thus in image transmission it is necessary to give more protection to significant bits as compared to the insignificant bits rather than giving equal protection to all the bits [1].

4. Comparison of QAM and HQAM

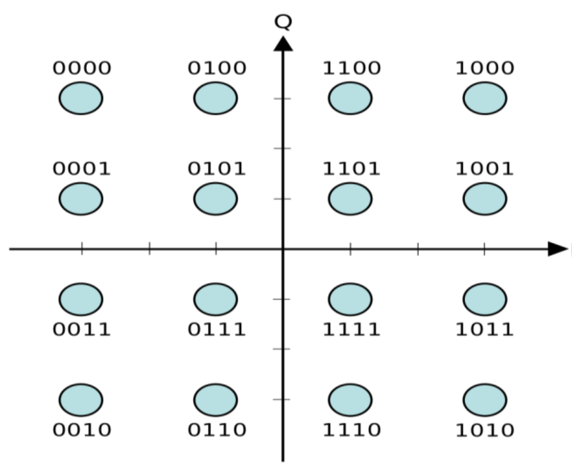
Quadrature Amplitude Modulation (QAM) is a big name for a relatively simple technique. QAM provides equal error protection to the transmitted bits by assigning equal priority to both the significant and non-significant bits of data; hence it is classified as equal error protection (EEP) method of modulation. This, however, is not desirable in case of image transmission where unequal error protection (UEP) is needed. Performance can be increased even more by putting extra protection on the highly sensitive bits than low sensitive bits using unequal error protection (UEP) schemes. Hierarchical QAM which is a modification of QAM, has the property of providing un-equal protection and can, therefore, be used to advantage in transmission of images over wireless erroneous channels. HQAM provides better transmission and Moderation in value of modulation parameter results in increase in PSNR and low BER [9]. HQAM provides more coverage area for important information. It also provides better degree of protection.

5. CONSTELLATION DIAGRAMS

As the order of the modulation increases, so the number of points on the QAM constellation diagrams. The constellation diagrams show the different positions for the states within different forms of QAM, quadrature amplitude modulation. The figure 3 shows the constellation diagrams for a variety of formats of modulation.



(a)



(b)

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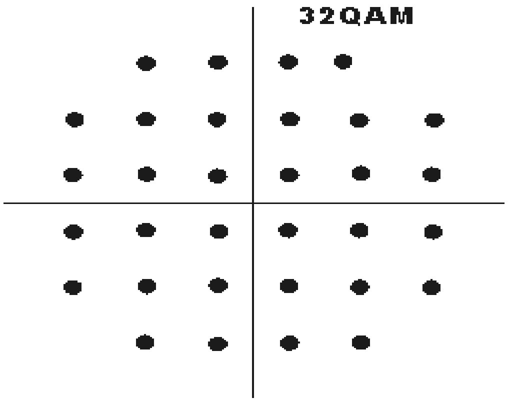
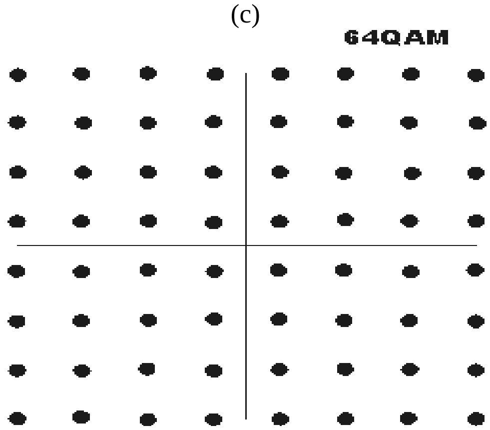
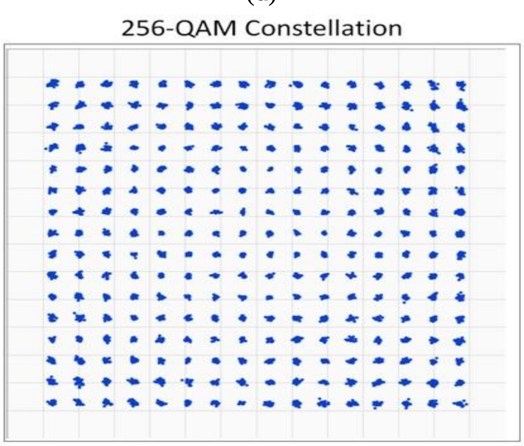


(c)



(d)



(e)

Fig. 3 Constellation Diagrams (a) BPSK (b) 16 QAM (c) 32 QAM (d) 64 QAM (e) 256 QAM.

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased.

The table I give a summary of the bit rates of different forms of QAM and PSK.

Table I: Bit rates of different forms of QAM and PSK

Modulation	Bits per symbol	Symbol Rate
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

6. CONCLUSION AND FUTURE WORK

From above survey, we can conclude that Quadrature amplitude modulation (QAM) is a digital modulation technique in which both the amplitude and phase of a carrier are modulated to convey digital information. Each signal carries equal part of the bit stream. At the receiver they are separated, the bits are read and then recombined to create the original bit stream. HQAM is a simple and efficient approach in which a non-uniform signal space constellation is used to give different degrees of protection. The advantage of this method is that different degrees of protection are achieved without an increase in bandwidth; in contrast to channel coding that increases the data rate by adding redundancy. One major drawback of conventional HQAM is that there are fixed allocated capacities for the high priority (HP) and low priority (LP) data layers (e.g. for 64-HQAM, 33% for HP and 66% for LP). However, in data partitioning, the corresponding parts of the coded data do not necessarily produce a constant bit-rate ratio. Therefore, conventional HQAM is not well suited to such application without either accepting delay or losing HP protection. To overcome this problem, a 256 HQAM arrangement is done with hierarchical oriented OFDM modulator for the digital image transmission is required.

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