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Image Transmission Over Erroneous Wireless mobile Channels using HQAM Techniques

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Abstract This paper examines the process of sending an image over wireless mobile Channels with errors while maintaining bandwidth, transmission speed and image quality. With the tremendous development in networks, new wireless channels have been opened that threaten the security of data transmitted through networks and communication channels, and from this emerged Encryption techniques to increase the security of the transmitted data, and since the digital image compression algorithm is a process to reassemble the parts of the image so that it takes less space, but this increases the impact of the error extension in sending compressed digital images and greatly reduces the quality of the received image. This prompts us in this paper to study the performance of HQAM technology for the purpose of transmitting image data over wireless communication channels containing errors. In this paper, image quality performance has been evaluated by the BER, SNR, PSNR, SSIM, and Correlation evaluation criteria. The simulated results show that there is an improvement in the image quality received using the proposed technique.
Keywords: image , HQAM , unequal error protection UEP.

أرسال صورة عبر القنوات اللاسلكية ذات الأخطاء باستخدام تقنية HQAM

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الملخص هذا الورقة تدرس عملية أرسال صورة عبر قنوات الاتصال اللاسلكية Wireless mobile Channels ذات الأخطاء مع الحفاظ على عرض النطاق الترددي و سرعة الأرسال وايضاً جودة الصورة . مع التطور الهائل الذي تشهده شبكات الاتصال فتحَ قنوات لاسلكية جديدة تهدد أمن البيانات المنتقلة عبر شبكات وقنوات الاتصال، ومن هنا ظهرت تقنيات التشفير لزيادة أمنية البيانات المرسلة. وبما إن خوارزمية ضغط الصور الرقمية هي عملية لإعادة تجميع أجزاء الصورة بحيث تأخذ مساحة أقل ولكن هذا يزيد من تأثير امتداد الخطأ في إرسال الصورالرقمية المضغوطة و يقلل بشكل كبير من جودة الصورة المستلمة. في هذه الورقة تم تقييم أداء جودة الصورة بمعايير التقييم BER و SNR و PSNR و SSIM و Correlation ، وسنتناول شرحها في المحور المخصص لها ، وتبين النتائج العملية أنه كلما زادت قيمة SNR زادت جودة الصورة المستلمة بأستخدام التقنية المقترحة.
الكلمات المفتاحية: صورة، تضمين مطالي متعامد عالي الرتبة، عدم المساواة في حماية الخطاء.

Introduction

When sending pictures via wireless communication channels, there are obstacles that affect the process of sending pictures, which is the limited bandwidth and the high probability of errors in the channel from interference to different signals and the resulting interference in the wireless channels. So image compression is applied when transmitting data to maintain bandwidth. This results in image distortion and thus contributes to a significant reduction in image quality. Therefore error Control techniques are used to control errors, but adding check bits that do not carry any actual information will increase the data rate and thus the transmission bandwidth will increase. Inclusion technologies such as QAM and QPSK give ways to protect from equal errors for all encoded bits without Increased bandwidth.

In This paper proposes using an asymmetric modulation method known as the Hierarchical Quadrature Amplitude Modulation to transmit images over wireless communication channels. In order to reduce the errors resulting in the transmission process, this method is a development of the method to include Quadrature Amplitude Modulation (QAM) and it gives unequal error protection (UEP) and it is a simple and effective method where a set ofirregular signals

are used non-uniform signal-constellation to protect the transmitted bits at varyinglevels. The most important advantages of this method are that it provides different degrees of protection without increasing the bandwidth, unlike the channel coding methods that increase the data rate by attaching additional bits (redundancy) to the transmitted signal. [2, 3,5].

The performance of HQAM technology will be studied in order to demonstrate its advantages in the event that image data is transmitted over the error-containing wireless communication channels. The BER, PSNR, SSIM, and CORRELTION correlation coefficient between the transmitted image and the received image via the proposed technology will also be analyzed and tested in AWGN (Additive White Gaussian Noise channel) environments, for performance analysis. Through simulation using the MATLAB program).Organize the research paper so that the axes are discussed in the following way: Discuss Part 2 - Effects of noise and distortion in transmitting images. Whereas, Part 3 explains the inclusion of the HQAM. Part 4 focused on the explanation of the image transmission model using the proposed HQAM technique. Part 5 - clarified the criteria used to evaluate the performance of 16-HQAM technology in the image transmission process. As for part 6 - he deals with the results obtained practically then. The paper concluded with a summary and references.

Effects of noise and distortion in the transmission of images

The transmitted image is subjected to noise and noise during its passage through the transmission model, the most famous of which is salt and pepper noise, and it appears as black and white light points in the image randomly, meaning that a certain percentage of pixels in the digital image are randomly numbered with extreme intensity, and this type causes Noise from images transmitted either through wrong locations of memory or transmission via communication channels with errors. Fig 1 (a) shows the image in normal, while Fig 1 (b) and Fig1 (c) shows the effect of salt and pepper noise on the received image.

Fig. 1: (a) the image in normal

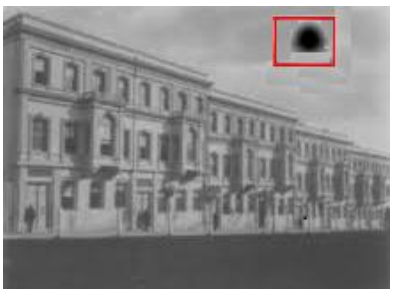

Fig. 1: (b) shows the effect of salt noise

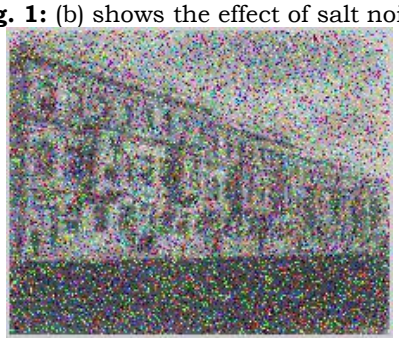

Fig. 1: (c) the effect of pepper noise

Note in Fig 1 (b and c) that distortion occurs in images when errors cause errors and there are differences in the scale of the image and the location of the coordinates of the pixels of the image. The distortion becomes more intense when errors occur in the (high priority HP) bits of the received signal. When errors occur in bits (of high priority LP), the distortion will not be apparent. This can be seen from Figure 1 (B and C). [7- 5 - 8].

HQAM (Hierarchical Quadrature Amplitude Modulation)

HQAM technology is a type of modulation patterns with features that are different from the modulation patterns known in the communication sciences. It gives different degrees of protection for the transmitted data bits in which high priority (HP) bits are allocated to the most significant bits (MSB) most significant bits. Low priority LP is assigned to the least significant bits (LSB) bits for the inclusion group points. Therefore, the use of HQAM technology will improve the picture quality of the channel's SNR signal-to-noise ratio, because HP's high-sensitivity data bits are assigned to MSBs with a low BER bit rate in HQAM technology. This is shown in the following chart.

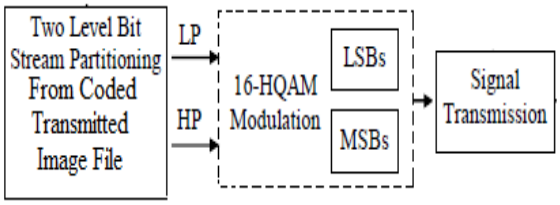

Fig. 2: Distribution Sample Hp , Lp to MSBs , LSBs

For simplicity's purpose, a brief explanation of the 16-HQAM technique will be presented in this paper. In general, in the HQAM technique it will be possible to give higher protectio n to the most important data (significant bit) by changing the value of the modulation parameter α. Where α = b / c is the ratio between the distance between quadrants b to the distance c between points within one quarter in the point totals chart where ((b / 2) + c) represents the constant k. [7] ..

The explanation above can be illustrated by a plot of 16-HQAM inclusion point points. Figure 3 (a) shows the diagram in when the results of the 16-HQAM and 16-QAM techniques are equal where the value of the inclusion parameter α = 1 i.e. when b = c HQAM will convert to QAM.

Figure 3 (b) shows the aggregate diagram of α = 2 i.e. when b = 2c and k = 2 In addition to this, the value of α must not exceed the square root of the carrier power Pc otherwise the aggregate points in the same quadrant will overlap

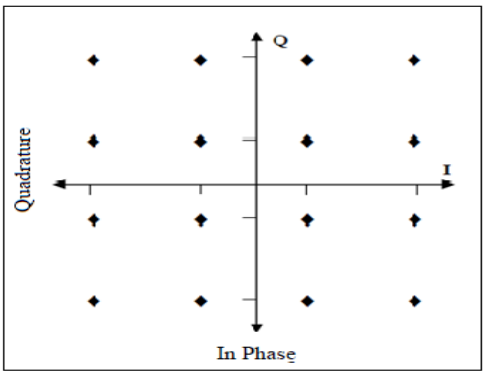

Fig. 3: (a) 16-HQAM Constellation Diagram at α=1

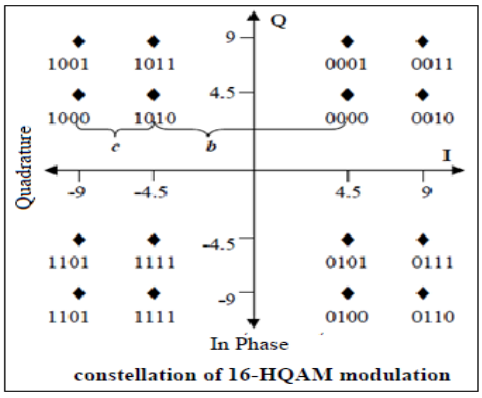

Fig. 3: (b) 16-HQAM Constellation Diagram At α = 2, k = 2

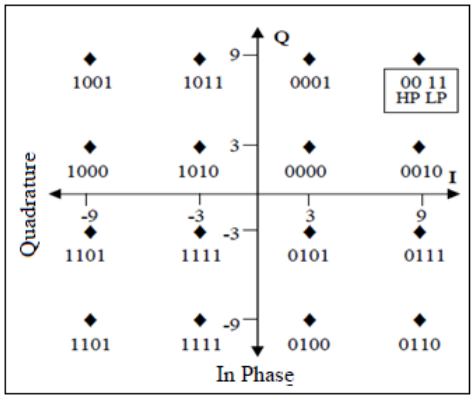

Fig. 3: (c) 16-HQAM Constellation Diagram

Images Transmission Using The Proposed Hqam Technology.

The model shown in Figure 4 illustrates the basic components of the image transmission system that the study will be conducted on.

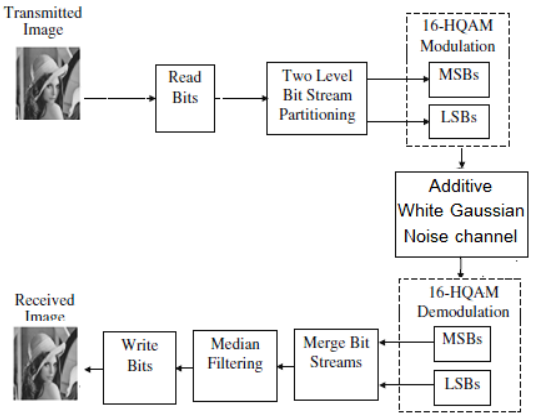

Fig 4: Block diagram of the proposed UEP Scheme

From the figure, we can clarify that the process of transmitting the image through the wireless channel is done in several steps as follows: -

1- Reading the image and converting it into a single matrix, each value in pixels, then converted to a Binary Stream Matrix.

2- Divide the Binary Stream Matrix series into two substream parts**,** Two Level Bit Stream Partitoning are Hp & Lp, so that the Substream series portion is left to right MSB to Hp, and the rest of the string from that row LSB is assigned to Lp.

3- HQAM technology is used consistently as an embedding technology for the data to be sent.

4- The data is transmitted and tested in AWGN (Additive White Gaussian Noise channel) environments,

5- The demodulator receives the image which contains the errors and decodes it.

6- The resulting data is allocated after the decoding process, the substream chain from left to right MSB to Hp, and the rest of the string from that row LSB is allocated to Lp, and it is collected in the digital data matrix.

7- Converting data from a digital array to pixel mode.

8- Reshape and display the matrix. [2-6-7-8].

Criteria used to evaluate the performance of 16-HQAM technology in the image transmission process

In this paper, some of the criteria will be used to analyze and evaluate the performance of HQAM technology in the image transmission process. These standards include BER, SNR, PSNR, SSIM, and Correlation. We will explain them as follows: -

1- BER (BIT ERROR RATIO) in digital transmission is the number of errors in the bits received for the data stream transmitted through the error communication channel (containing noise) with respect to the total number of bits transmitted during a time period, meaning that they are calculated by the number of bits received (error bits) Divided by the total number of received bits .

$$\mathbf{BER} = \frac{\mathbf{N\ Err}}{\mathbf{N\ bits}} \qquad \mathbf{(1)}$$

Where ***N Err*** is the error bit and ***N bit*** is the total number of received bits.

2- SNR (Signal Noise Ratio) is the ratio of the received signal power to the noise power in the allocated bandwidth of the communication channel and SNR is an important factor in evaluating the physical layer performance of wireless communication networks. SNR is calculated by the following formula : -

SNR = 10 log10 (Signal / Noise) dB (2)

3- PSNR The Peak Signal to Noise Ratio (PSNR) . It is the signal-to-noise ratio between two images and is often used to measure image quality between the (original) image and the received image High values of PSNR mean the best image quality and are calculated by the following formula :.

$$\mathbf{PSNR} = \mathbf{10}\log_{10}\frac{255^2}{\frac{1}{MN}\sum_{i=1}(r_n - x_n)^2} \qquad \mathbf{(3)}$$

Where r_n: the recovered improved image. xn: the original image. ***M***and ***n***: the image dimensions and represent the number of points treated.

4- CORRELATION

It is one of the ways to calculate the probability of the degree of linear relationship between two quantities and symbolizes the correlation coefficient with the symbol r and is calculated by the following formula: -

$$r = \frac{\sum_m\sum_n(A_{mn}-\overline{A})(B_{mn}-\overline{B})}{\sqrt{(\sum_m\sum_n(A_{mn}-\overline{A})^2)+(\sum_m\sum_n(B_{mn}-\overline{B})^2)}} \quad \mathbf{(4)}$$

Where

Bmn and ***Amn*** are the density of the pixel value in the transmitted and received image, respectively, and the correlation coefficient value r is equal to 1 if the two pictures are identical and equal to 0 otherwise, and if there is a difference then the value of r is less than 1. [1-3-4-8] .

Results

In this paper, we conducted a study to simulate the gray image transmission system using the HQAM-16 technique and using the MATLAB program where the transmitted image was compressed as shown in Figure (6-a).Signal Noise Ratio.

Fig 6: (a) the original image

Fig 6: (b) SNR = -5

Fig 6: (c) SNR = 1

Fig 6: (d) SNR = 3

Fig 6: (h) SNR = 5

Fig 6: (x) SNR = 10

Note that the received image is shown in the figures from (6-b) to (6-x) as a result of using the HQAM technique, there is an improvement in image quality, as it was noticed that the higher the value of SNR, the more clear the received image and the less the distortion percentage.

The performance evaluation of the 16-HQAM technique in the process of sending the image

Also through simulation, the performance of HQAM technology in image transmission process through AWGN channel was analyzed and evaluated, as shown in the following figures.

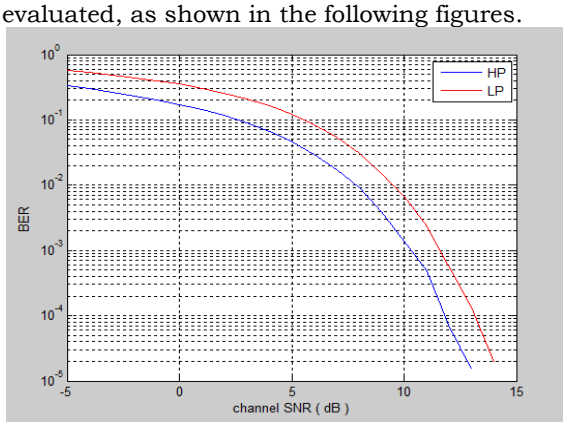

Fig 7: (a) Relationship Between BER and SNR (DB) for HP & LP

The figure shows the relationship between (BER) and (db) SNR through the AWGN channel for both Hp and Lp where we note that the lower the BER the less HP and the LP increase the value of the SNR capacity and this shows that HP data are more protected using the proposed technique HQAM

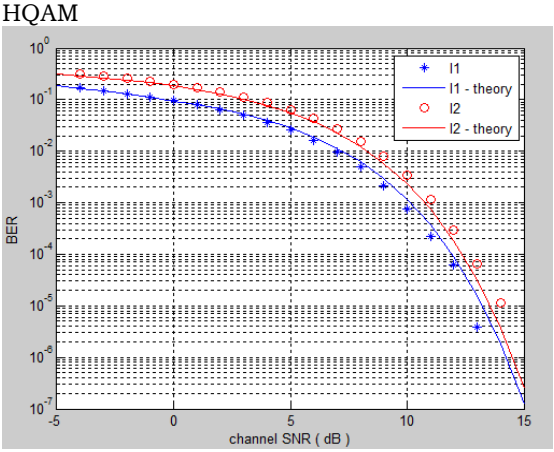

Fig7: (b) The relationship between (BER) and SNR (DB) for HP & LP

The figure shows a comparison between the simulation results and the theoretical calculations of the proposed HQAM technique. We notice from the figure that the simulation results for both HP & LP are very close to theoretical calculations, and this indicates that this technique provides protection for the image data sent

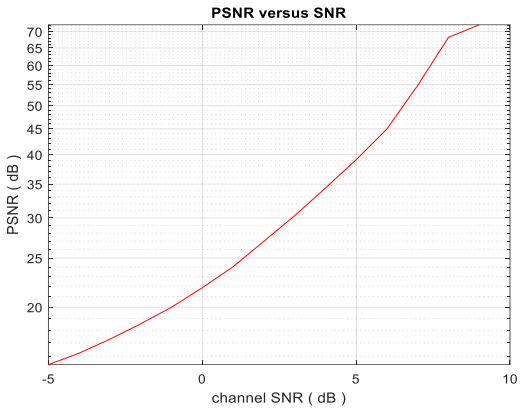

Fig 7:(c) Relation between PSNR and SNR (DB)

Figure shows relationship to (PSNR) and SNR (db). In order to evaluate the received image quality if the image is sent using the proposed HQAM technique, the figure shows that the higher the SNR, the greater the PSNR, where the value of PSNR reaches about 70 db when the SNR was 9db. reaches about 1 when the SNR was 5db. Meaning, the curve shows the extent of correlation between the received image and the transmitted (original) image. Simulation results show that there is an improvement in the image quality received using the proposed technique.

Conclusion:

To send pictures via Wireless mobile Channels, the technologies used in digital communication science provide the highest transmission efficiency by taking advantage of the inclusion (change of amplitude and phase), but they require greater bandwidth since they give equal protection against error to send bits of image data by allocating Equal priority for both bits of interest and useless. While HQAM provides different degrees of protection for the data bits transmitted for each bit of interest and importance, meaning that during our study of HQAM technology that will provide higher protection for high priority bits and less protection for low priority bits this will improve the quality of the received image. Thus, the HQAM method is a simple and effective modification as compared to the techniques used in digital communication sciences, and it provides an effective way to sendimages over wireless (error) channels without the need to make any additions to the system's physical components.

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