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# EFFECT OF DIGTAL MODULATION SCHEMES ON QUALITY OF MEDICAL IMAGES

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**Abstract:** Sending/receiving high profile image over noisy channel is a significant research area and considered to be focusing topic by engineers, where high transmission rate of accurate images (medical) is increasingly required. In this paper, many digital communication techniques have been examined, the experiment is performed to offer a viewpoint on the foundation of image processing in digital communication system. Visual Basic Access application is built to diagnose teeth images, in order to perform many processes such as cavity-spot, grey-scale conversion. Matlab simulations have been performed to send/receive the diagnosed image and to evaluate the performance of BPSK and QPSK under AWGN and flat fading channels of SISO (1Tx, 1Rx) system , moreover comparison of (BER,MSE and PSNR) parameters between BPSK and QPSK modulation scheme using different SNR values ( 2dB, 5dB, 7dB, 10dB, 12dB, 20dB and 30dB) is simulated. Modulation techniques BPSK and QPSK have the same results under the same channel, but QPSK modulation is better because of its higher data rate, as it is essential for image processing.

**Keywords**: ADWGN, Flat fading, grey Scale, MSE, PSNR, and Teeth Cavity.

## Introduction

Digital image processing performs certain procedures on an image in order to achieve a required image specifications or to obtain suitable data from it, digital image processing is used in many areas, such as in pattern recognition, medical field and industrial fields. For example, in medical fields, image processing helps in detections of tooth cavity through X-ray and colored images.

Medical imaging technologies such as X-rays and color images assisted the cure and analysis of diverse illnesses [1]. In dentistry, dental data acquisition is an growing area, which, in the other hand, leads to enhance the cure and analysis process, increases efficiency and decreases pressure during the daily performance [2].

Sending/receiving an image over a wireless channel involves an image to be well-matched with the channel specifications such as capacity. The image data take a huge memory in the hardware which consumes time to be sent through a wireless channel, therefore transmission data rate, which is the main characteristics of each modulation scheme and SNR level which one of the channel parameters play important role in the transmission / receiving process.[3]

## Objectives

The aim of this paper is to send a medical image over wireless channel and evaluating the diagnosed image at the receiving terminal, as well as to build VBA platform to computerize the diagnose process.

**PROPOSED METHODOLOGY AND SIMULATION RESULTES**

the practical part of the proposed system is illustrated, as well as the simulation steps for performing the detection process for tooth cavity.

**1-The Proposed System**

The proposed algorithm mainly relies on recognition and detection of tooth cavity from colored image which automatically identifies features of tooth cavity. The designed system is divided into three main stages which are image acquisition, gray scale conversion and color map. These stages are illustrated in figure 1.[3]

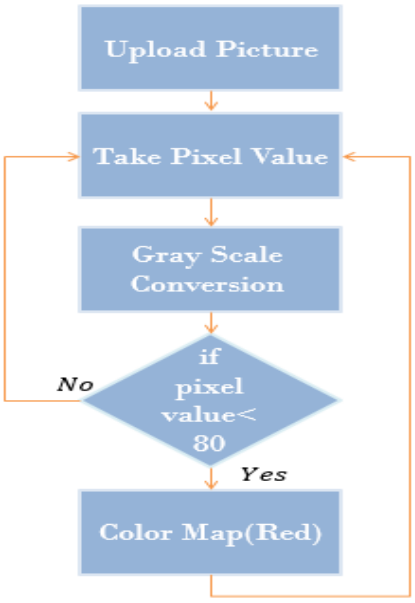



**Fig.1:** Flowchart of the Proposed System.

**2-The System User Interface.**

Visual Basic Access application has been used for implementing the tooth cavity detection system. Graphical User Interface GUI as shown in figure 2 enables the user to interact with application, and views the system processes, It has advantages of being an easy-to-use tool for operator without any complexity in the design.[4]

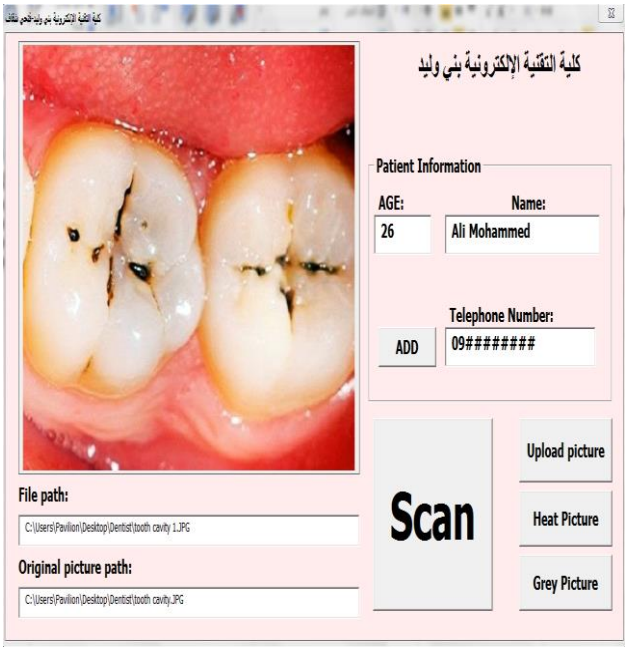



**Fig.2:**Result of selecting upload picture button.

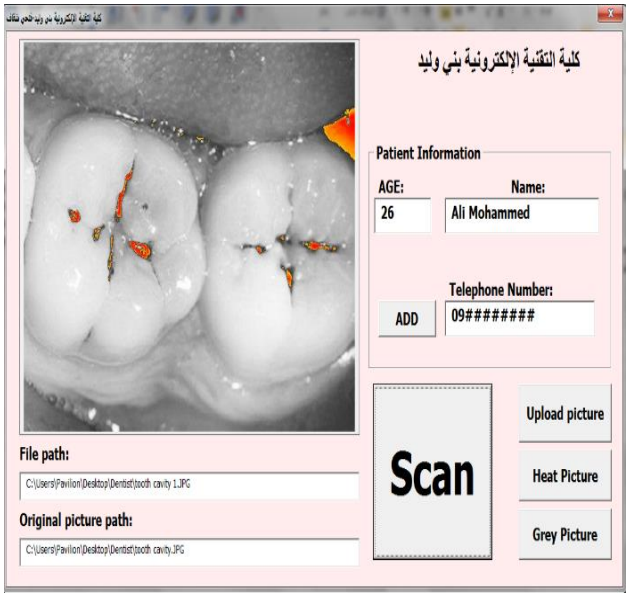



**Fig.3:** Result of selecting scan button.

**3-Image transmission over wireless channel**.

MATLAB is used to simulate the experiment. Where different modulation schemes are examined under various levels of signal-to-noise (SNR) ratio.

Quality of image reduces because of distortions during image decoding and treating. Distortion happens as blast, blare, noise, and compression errors. If distortion less image (if exists), can be used as a reference to evaluate the quality of received images. For instance, when evaluating the features of compressed images, an uncompressed copy of the image offers a beneficial reference. In these suitcases, full-reference quality parameters to immediately analyze the received image and the sent image. In this study the Image before transmission is used as reference.

Common systems relate the arrived image with a pre-stored image (with zero distortion), some generally used parameters include:

**1-Mean-squared error (MSE).**

MSE takes the difference between each pixel and its peer in the reference image, and squares it, and then determines the average of the squares. This method is easy to compute and stochastically adequate .[5]

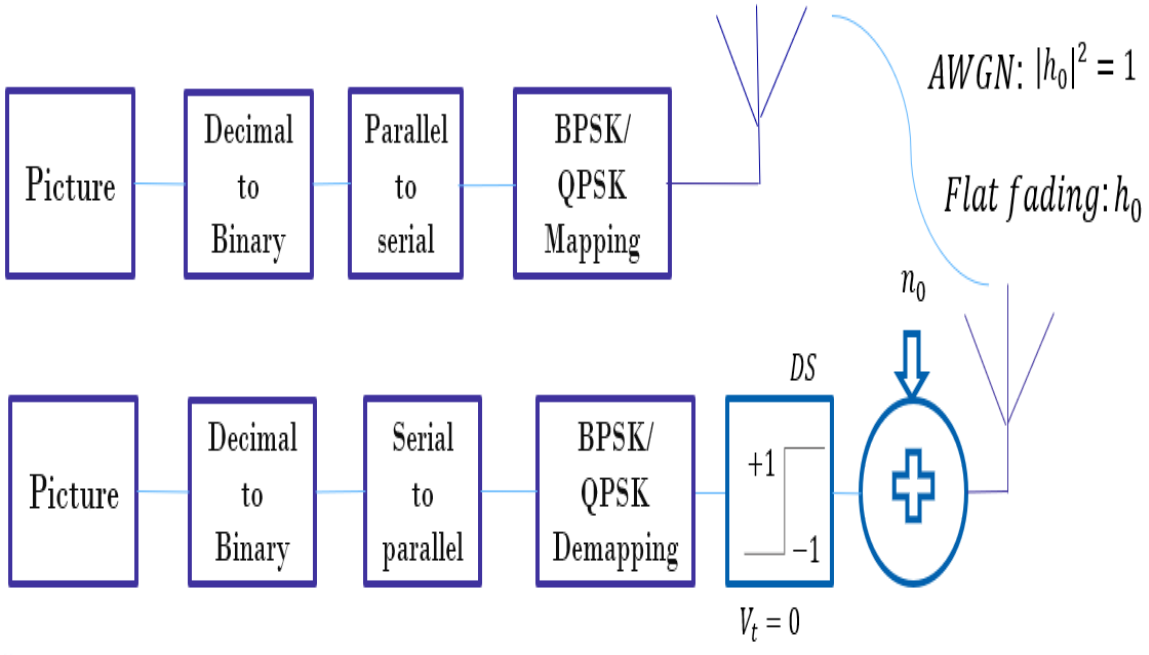
$$MSE=\frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=1}^{n-1}[I(i,j)-K(i,j)]^2 \qquad (1)$$

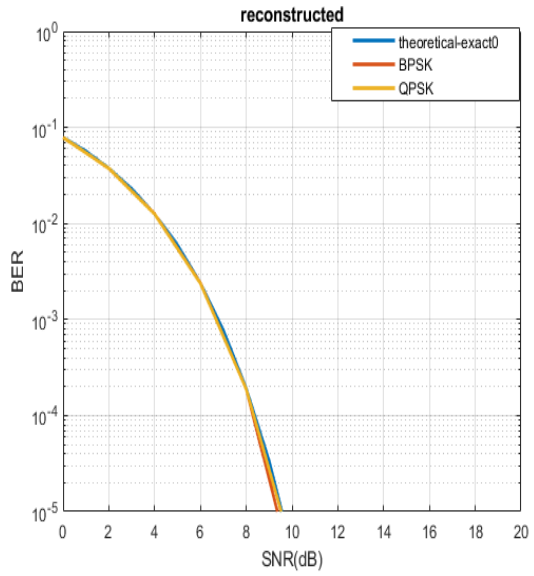
**2-Peak Signal-to-Noise Ratio (PSNR).**

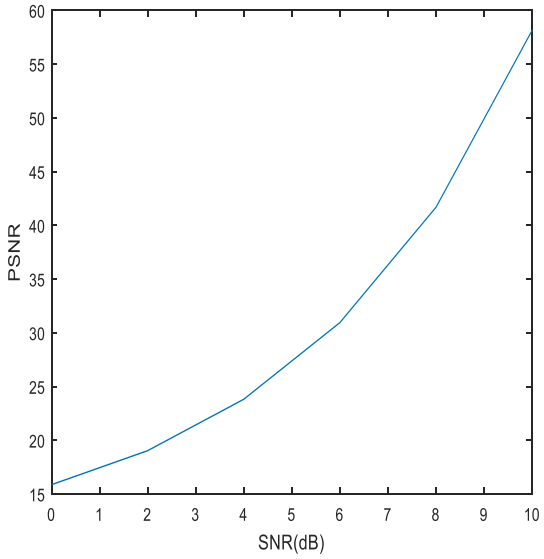
PSNR is inspired by the mean square error, and calculates the ratio of the extreme pixel strength to the distortion. the PSNR is also easy to be determined and can be considered a reliable parameter.[5]

$$PSNR=10*\log_{10}\left(\frac{\text{Maximum}_i^2}{\text{MSE}}\right)$$

**Fig.4**:Schematic Diagram of SISO system with BPSK/QPSK modulation scheme over AWGN or Flat fading channel.






$$=20*\log_{10}\left(\frac{\text{Maximum}_I}{\sqrt{\text{MSE}}}\right) \quad (2)$$

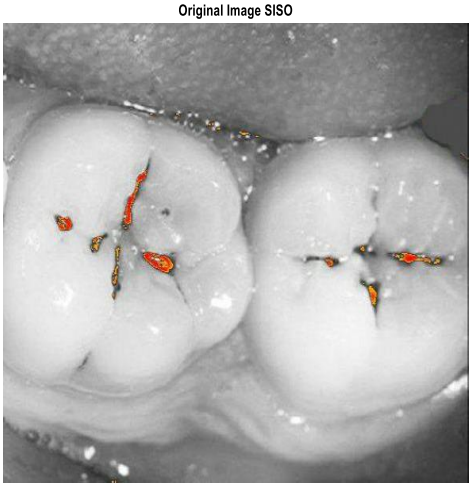
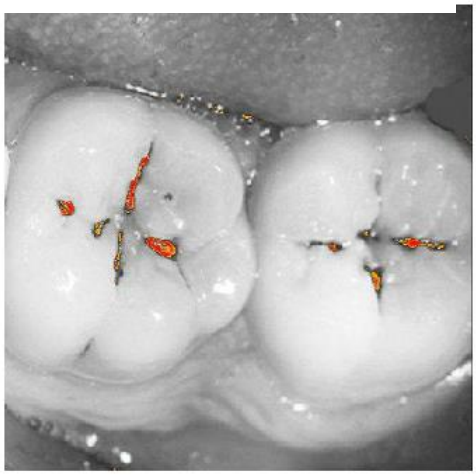
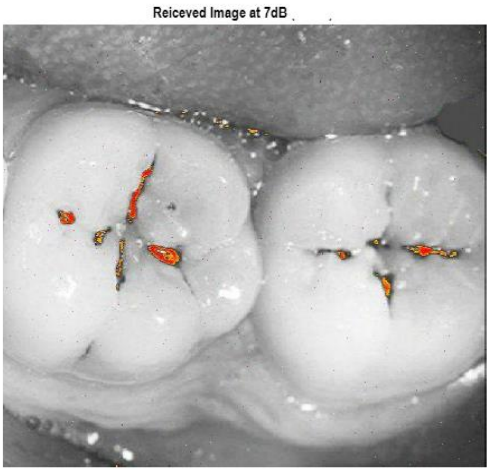



**Fig.5:** BER performance of SISO over AWGN channel with BPSK/QPSK modulation scheme.


**Fig.6:** PSNR performance of SISO over AWGN channel with BPSK/QPSK





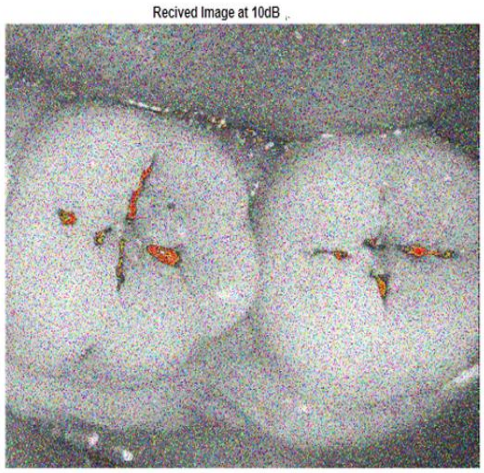
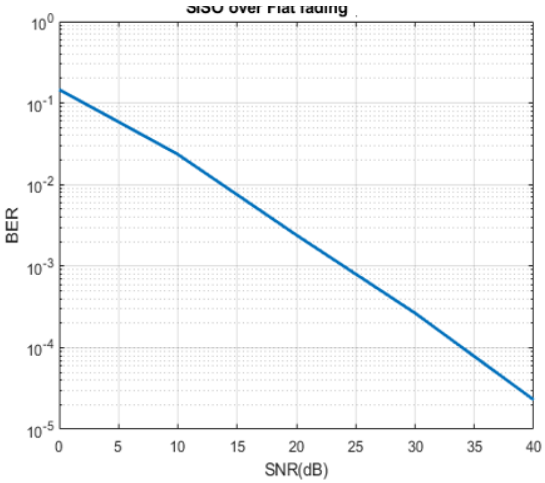




**Fig. 7**: Received image at 2dB, 5dB ,7dB ,10dB , and 12dB of SISO system over AWGN channel with BPSK modulation scheme.



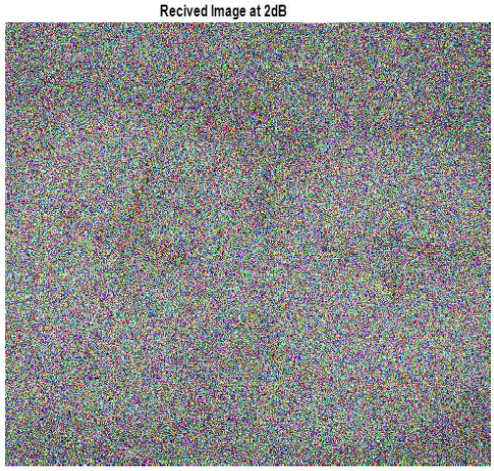
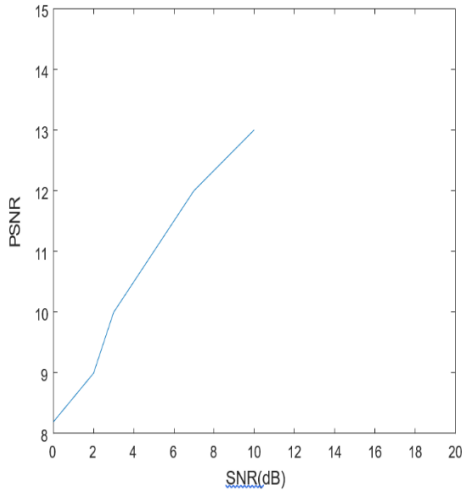




**Fig.8:**BER performance of SISO over flat fading channel with BPSK /QPSK modulation scheme.



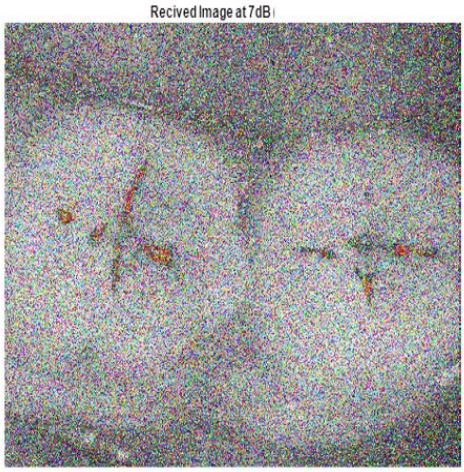




**Fig.9:**PSNR performance of SISO over flat fading channel with BPSK/QPSK modulation scheme.


**Figure 10:**Resived image at 2dB, 7dB, 10dB, 20dB, and 30dB of SISO system over flat fading channel with BPSK modulation sachem.

.It has been observed that the proposed VBA algorithm is reliable in terms of accuracy and processing time, as it accomplishes grey conversion and cavity spotting in about twenty one seconds, which makes diagnose process simulation appropriate. Especially large cavity spots because they need more threshold and therefore higher running time.

The image transmission over communication system using digital modulation techniques is performed and the results are obtained through a high level technical language called MATLAB. MATLAB was introduced for designing and implementing wireless digital communication system. Like many of the other wireless digital communication systems, the performance of this system is acceptable up to a certain level of noise.

Increasing SNR leads to lower BER which produced less MSE and higher PSNR and the result is good image quality

Through AWGN channel, 10 dB level is considered to be suitable for both modulation schemes, which produce almost acceptable received image and low BER value. The performance under AWGN is better than Flat fading channel, where BER is 4 errors are recorded out of million bits under AWGN, while under flat fading 235 errors out of ten thousands bits. In terms of MSE, 0.0825 for AWGN channel which much less than the recorded value of flat fading (3597.5). PSNR is also much better in the case of AWGN channel (58.96), while in flat fading is worse (12.57).

Comparing to [4][5] more detailed results have been presented, where flat channel is considered beside to the additive channel, and also MSE and BER parameters are documented

in this experiment. Furthermore, better results are achieved in terms of PSNR under QPSK/Binary Modulation.[5][6]

values at different SNR of SISO system over AWGN channel with QPSK modulation scheme.

**Table 1**: Comparisons of BER, MSE ,and PSNR

| SNR | BER | MSE | PSNR |
|---|---|---|---|
| 2 dB | 0.1305 | 7163.13 | 9.5798 |
| 7dB | 0.0508 | 3852.44 | 12.2734 |
| 10dB | 0.0235 | 3597.4961 | 13.5708 |
| 20dB | 0.006 | 0 | inf |
| 30dB | 0.0024 | 0 | inf |

**Table 2**: Comparisons of BER, MSE ,and PSNR values at different SNR of SISO system over flat fading channel with QPSK modulation scheme.

| SNR | BER | MSE | PSNR |
|---|---|---|---|
| 2 dB | 0.0376 | 813.4503 | 19.0523 |
| 5dB | 0.0060 | 133.4433 | 26.8778 |
| 7dB | $7.7621x10^{-4}$ | 17.1271 | 35.7940 |
| 10dB | $4.6007x10^{-6}$ | 0.0825 | 58.9641 |
| 12dB | 0 | 0 | inf |

**CONCLUSION**

VBA platform has been successfully built to diagnose tooth cavity and to give general internal view for the oral area using heat conversion, where conversion to grey scale helps detecting cavity, as it simplifies the color image and therefore reduces the algorithm's complexity.

Digital Image Processing system has been simulated by Matlab, the performance of the system is acceptable, up to certain level of SNR. 10 dB using both BPSK and QPSK, under AWGN channel, as SNR value increases, MSE decreases and PSNR increases, which means better image quality.

Under flat fading channel, at 10 dB MSE value is 3597.5 and value of PSNR equal to 12.57, which produced relatively distorted received image.

Under AWGN channel, at 10 dB, PSNR = 58.96 has been recorded, and MSE=0.0825, which produces almost identical received image/transmitted image, it could be concluded that better image quality is recorded over AWGN channel

Equal BER values are observed for both BPSK and QPSK schemes, keeping in mind, that QPSK has higher data rate, and more BW efficiency.

Based on the findings of this study, the researchers propose several avenues for future investigations related to the VBA platform. Firstly, enhancing the VBA platform by incorporating additional parameters, such as the degree of cavity, gum inflammation, and other relevant factors, may yield valuable insights.

Furthermore, the researchers recommend investigating more advanced modulation schemes, such as 16 Quadrature Amplitude Modulation (QAM) and 256 QAM, to potentially improve the communication efficiency and performance of the platform. Exploring multiple antenna techniques to mitigate the challenge of flat fading is another area worthy of further research attention.

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