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# SECURED HANDHELD MOBILE DEVICE COMMUNICATION USING BARCODE MODULATION BASED ON OFDM

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## Abstract

The inventions and high end technologies has great impact on digital communication domain which takes wireless communication to next level to support advanced applications and to offer high rates. Although tremendous progress has been registered in past few decades but still handheld mobile communication is concerned area in the wireless communications. Large data encryption in small space and data privacy is two drawbacks leads to manipulations in handheld mobile transmissions. In this paper a DWT based barcode modulation approach is proposed which makes use of DPSK-OFDM as primary resource to yield a secure handheld mobile transmission to support wide range of applications in reliable way. Finally the experimental results show the proposed DWT based mechanism yields low complexity and better performance over Fourier transform and that performance is measured in terms of BER and SNR.

**Keywords:** OFDM, Handheld transmission, DPSK, Digital communications, barcode, Fourier transform, wavelet transform

## 1. INTRODUCTION

The word 'information' not only represents the data but also created revolution in 21st century in terms of security and as well as communication. Information industry has registered enormous growth in last few decades because of invention of new wireless applications and digital communications has created a revolution which makes wireless communication domain as user friendly. The world of communication changes a lot in past century and the change starts from analog communication followed by digital communications which is then followed by virtual expansion. Despite the technological advancement still applications like business, advertising, and logistics depends heavily onphysical media for communication. Digital communication has wide range of applications in modern world but still the domination of paper is still continuing in various applications and this pose a situation of time consumption. Barcode implementation has changed the scenario and implementation of barcode increases

communication and improvise the communication in terms of data rate.

Data transmission through barcode has gained great prominence which guarantees encryption of data which ensures data privacy in reliable way by excluding the data piracy. Sending more data using less space for equipped transmission has attain attention and barcode is one application which takes less space for transmitting more data. . QR code [1] is another representation of barcode and has its own advantages in terms of encoding and decoding. Hiding the data for secure transmission is implemented in real time by converting the respective data into reliable QR code then followed by DPSK along with OFDM modulation scheme for achieving the secure transmission in various digital communication applications [2].

One of the most innovative invention ever happened in the security domain is 'barcode technology' and this barcode technology vividly used in many sections of Automatic Identification and Data Capture [1]. Barcode technology is classified into two type's namely (i) one-dimensional barcodes and (ii) Two-dimensional barcodes based on the application oriented encoding mechanisms. One-dimensional barcode appearance looks in a peculiar form consists of white and black lines in parallel form with essential spacing between them. Generally scanner reads the white lines excluding the black lines which decoding the barcode and it's the interesting fact about the one-dimensional barcode spacing consists of white and black lines. Two-dimensional barcode is a purely a graphical image which has ability to preserve the necessary information both in horizontal as well as vertical way. The major differences in terms of advantages are shown in tabular column 1 as follows.

| CONTENTS | ONE-DIMENSIONAL BARCODE | TWO DIMENSIONAL BARCODE |
|---|---|---|
| **Data capacity** | Low data capacity | High data capacity |
| **Additional storages** | Needs additional storages | No additional storages |
| **Error correction ability** | No error correction ability | Have error correction ability |

Tabular column 1: One- dimensional barcode vs Two- dimensional barcodes

Two-dimensional barcode have much more advantage over the one-dimensional barcode [8] thats why 2D barcode are most widely used. There are many 2D barcode are available from that some uses for camera phone applications these are QR code, visual code, data matrix, VS code. But along these codes QR code is more widely used in camera phone application since QR code is a unique code and it has a larger data storage capacity [3]. The detection of QR code by mobile phone in[11].

Transmission of data between two mobile devices through a series of 2D QR codes is studied in [5],achieving bit rates of under 10 kbps. Further idea is developed in [4], in which a monitor of computer and a digital camera are used for transmission and reception with bit rates more than 14 Mbps. This rate is drop to 2 Mbps as distance increases up to 4 meters from 14 meters. The better performance is achieved by using more effective modulation schemes. The general idea is to use inverse fourier transform of

data like OFDM to modulate LCD pixels studied in [2]. DWT have much more advantages over the fourier transform as in [6]. For further increase in performance is achieved by using wavelet transform (DWT) instead of fourier transform along with DPSK-OFDM is to be studied in this paper. The performance is to be measured in terms of BER (bit error rate) and SNR (signal to noise ratio).

## 2. OFDM

The word communication has great prominence in human life and the history of communication dated from early ages of human evolution (from Stone Age). Early communication is based on sign language and along with civilization communication too changes its face. Languages came into existence which makes communication much more efficient. The $19^{th}$ century has created revolution in the field of communication which results in wireless communication based on radio frequencies. The implementation wireless communication initially started in analog domain for data transfer but slowly it too fade out and digital communication came into existence where multi carrier transmission is implemented in place single carrier communication to make the process of communication easy and reliable.

Wireless networks has witnessed drastic improvements in terms of data rates from last few years ranging from 10Kbps to 10Mbps and sometimes beyond that limit. The demand of high speed communications in wireless networks increasing due to advancement in technology. Broadband channels efficiently utilized the modulation schemes and its properties in effective way to offer high speed communications for different wireless applications.

The data analysis and data system of OFDM are in parallel and unique approach of OFDM is dividing the channel into sub channels for supporting multi carrier modulation scheme. Channel division into sub channel helps in creating the orthogonality at transmitter side and separation of the sub channels at the receiver section. Initially serial data symbols are converting to parallel data stream and each parallel data stream has sub channel and the symbol rate of individual sub channel is lower compare to original channel symbol rate. As the symbol rate of sub channel is lower than original channel symbol rate which makes sub channel appearance looks like as flat fading channel. OFDM has advantage of avoiding adjacent sub channels distortion is effective way by adding by additive burst noise in random way. OFDM is a flexible modulation scheme to combat against the interferences by inserting guard intervals and has ability to offer high data rate.

OFDM scheme is strictly designed to offer high speed communications for different applications and users respectively. OFDM understands real data (real input at transmitter end and real output at receiver end). ITU-RF approves orthogonal frequency division multiplexing (OFDM) as future generation system which offers high data rate, low complexity, no interferences and finally better spectral efficiency. Although OFDM offers wide range of advantages but drawbacks like PAPR, timing jitter frequently decline the performance levels along with cost of the system. Orthogonal frequency division multiplexing (OFDM) communication model has following factors

(a) Spectral efficiency

(b) BER performance

(c) Attenuation factor

(d) Channel factors

(e) High power amplifier

(f) Orthogonality

## 3. PROPOSED METHOD

Demand for high data rate communication system leads to design of OFDM architecture which offers high data rate up to 100mbps. Introduction of blur in digital images has become a major concern area in the data transfer and usage of orthogonal subcarriers from OFDM has successfully handled the problem of image contamination. Orthogonal frequency division multiplexing scheme utilizes the low pass filter in efficient way to ensure the transfer of low frequency bits in uncontaminated way and only requirement needed is high phase coherency which helps in detect data bits in accurate and reliable way. A detailed explanation with well defined modification is presented in this paper based on above study and the proposed idea mainly relies on equipped modulation scheme along with LCD camera [9] movements which is used in capturing the single frame and the acquired images are perceived in better way.

DPSK modulation scheme is literally called as heart of the proposed work and adjacent frequencies phase differences leads to DPSK modulation. DPSK modulation usage comes into implementation when data is inscribed in phase differences based on the required movement tolerance. Finally DPSK-OFDM termed as DPSK method in entire project till end. Generally phase differences in data transfer results in phase distortion may affect the relative neighboring components in negligible way and usage of DPSK modulation handle the distortion situation in better way which paves way for transmission even in high LCD vicinity and in camera relative motion. A related figure composed of LCD camera movements along with communication standards is shown in figure 1 and the mechanism presented above successfully eliminates the unnecessary channel estimation requirements which results in low processing power.

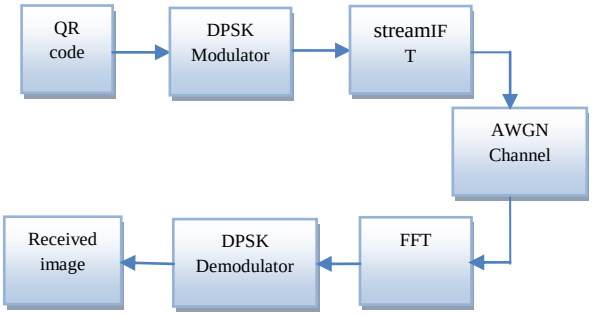


Figure 1: Transmission of information using DPSK Algorithm

Transmission information from the transmission end at maximum level is a concerned area especially from a single image and in order to meet the criteria, maximum data must be extracted from the single which is followed by increasing the data rate of the consecutive frames for decoding purpose. Extraction of the information depends on the LCD display design while in some cases it depends on the receiver end camera respectively.

### (A) DATA CAPACITY

Data capacity is crucial part in data transfer from transmission end to receiver end though channel. Number of bits viewed on LCD screen especially of raw image. A color image shown on display composed of rows and columns as ‘M’ and ‘N’ and transmission of data is done through channel

represented as $L_D$ and depth of color bit $B_D$bits per channel. The maximum information is represented as

$C_I$=$M_D \times N_D \times L_D \times B_D$ *bits per image* … (1)

The discrete nature of the LCD display puts serious limitations to perceive maximum information as shown in above notation and desired information rate cannot be achieved due to certain limitations as described below.

**(i) Power related Limitations**

According to the Shannon hypothesis theory, the power passing through channel is directly depends on the signal force. The signal force represents the speed achieved by the respective signal while it sent through the medium in effective way. So power limitations deployed in the communication theories pose major limitation is transmitting the information using barcode modulation. The major reasons which vividly cause power limitations are as follows

- Signal compression while transmission results in distortions. These compression distortions are the one of the predominant reason for causing power limitations.
- Subjective relative motion

**(ii) Finding the relevant patterns**

Modulation/demodulation is considered as heart of the modern day communication system which is offering high data rates to various indoor and outdoor applications by international communication standards. Extraction of inscribed information from respective barcode modulation is highly affected by power distortions. Standard finder pattern used for QR code is 1:1:3:1:1.

**(C) DPSK – OFDM**

Transmission of information through wireless scenario is possible because of reliable modulation schemes. In traditional approaches vast amount of modulation schemes along OFDM has implemented but none can achieve low complexity. In this work, DPSK-OFDM modulation scheme has implemented for better transmission of information from transmitter end to the receiver end. The transmission of information through DPSK OFDM approach is shown in following figure 1.Here the respective input taken is 'TEXT'. The encoding process helps in achieving secured QR code for reliable transmission. Encoding and decoding of QR code is achieved by Zxing open link source [10]. Cyclic extension is used to prevent the inter carrier interference (ICI) in a OFDM system [7].

**(i) DPSK Modulator**

DPSK takes the converted data as a input source. Each symbol is converted to a complex phase by following rules

$11^{\rightarrow}e^{\frac{j1\pi}{4}}$, $10^{\rightarrow}e^{\frac{j7\pi}{4}}$, $01^{\rightarrow}e^{\frac{j3\pi}{4}}$, $00^{\rightarrow}e^{\frac{j5\pi}{4}}$,

First bit modulates the Real component & second bit modulates the imaginary component of the phase of each symbol.

S matrix converted into Differential matrix D using following method:

• D(0,0)=S(0,0); (2)

• D(0,n)=D(0, n-1) × s (0,n)1≤n<N-2 (3)

• D(m, n)=D(m-1,n)×s(m,n)1≤m<M/2-1, 0≤n< N-2 (4)

D matrix is converted into two matrices:

• $D_1$(m,n)=D(m,n); (5)

• $D_2$(m,n)=D(m,n+N-2/2 ; (6)

Where 0≤m<M/2-1, 0≤n<N/2-1

These two matrices are used to fill regions 1 and 2 of the transmission matrix.

**(ii) IFFT**

IFFT is used to convert the frequency domain data into time domain. Output of DPSK modulator is in frequency domain, so IFFT is used to convert it in Time domain representation using following equation:

$$\mathbf{X[n]= \sum_{k=0}^{N-1} X(k) . e^{\frac{jk2\pi n}{N}} n = 0, 1, 2, \dots, N-1} \quad (7)$$

**(iii ) AWGN channel**

AWGN channel is widely used in OFDM. In OFDM multipath signals are transmitted then these signals are received as a train of pulses at the receiver .In this white Gaussian Noise are considered with constant spectral density.

**(iv) FFT**

FFT is used to convert time domain representation of data into frequency domain using following equation:

X[K]=1/N

$$\sum_{n=0}^{N-1} x[n]. e^{\frac{j2\Pi nk}{N}} k = 0, 1, 2, \dots, N-1 (8)$$

**(v) DPSK Demodulator**

Data can be extracted using phase differences between respective elements. Data corresponding to region 1 & 2 should be concatenated to form matrix R corresponding to transmitted matrix T.

• Rd(0,0) =R(0,0) (9)

• Rd(0,n) =R(0,n)×R*(0,n-1)0<n<N-2 (10)

• Rd(m,n)=R(m,n)×R*(m-1,n)0<n<N-2, 0<m <M/2-1

Finally, the received signal is to be detected as the phase differences have been extracted. Each input bit may be calculated using constellation map of the transmitter. Each element is evaluated using its real and imaginary components. The sign of the real component determines the first bit and sign of the imaginary components determines the second bit.

In wireless medium to increase the data rate with high performance orthogonal frequency division multiplexing (OFDM) is used which uses inverse fast fourier transform at the transmitter to modulate a high bit rate signal onto a number of carriers. The problem to this technique is that it requires more complex IFFT core. Over this, we can use discrete wavelet transform to generate the output with lower computational complexity. Extension diagram is as shown in figure 2. Wavelet transform is the most suited for use in AWGN channel and measures the performance in terms of Bit Error Rate (BER) and signal to noise ratio (SNR). It increases the spectral efficiency and decreases the bit error rate as compare to fourier transform and we get the better performance.

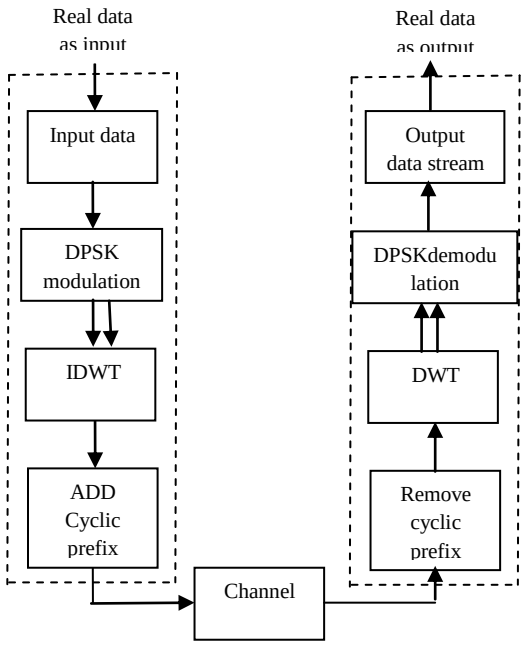


Figure 2: Extension method block diagram for data transfer using DWT

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## 4. RESULTS

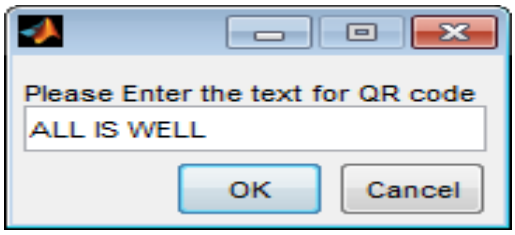


Figure 3: Input Text

Fig.3. Analysis: The first step is to enter the text to generate a QR code. Our main aim is to retrieve the entered text back. So, now I have entered "ALL IS WELL".

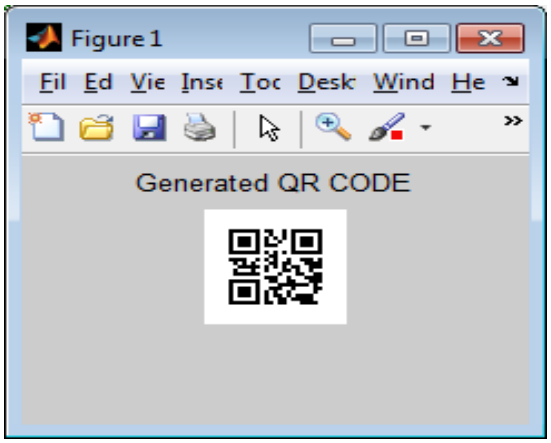


Figure 4: Generated QR Code

Figure 4: Analysis: The text which was entered is generated as a QR code as shown in the above Fig.


Figure 5: Received Image

Figure 5: Analysis: The generated QR code is captured by the receiver and this is analysed to extract the text entered.

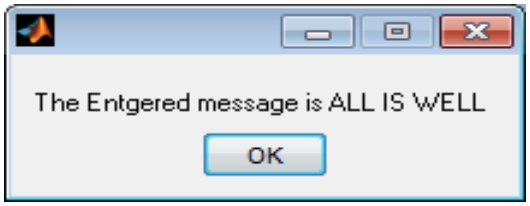


Figure 6: Shows Entered Text

Figure 6: Analysis: Finally the above QR code is analysed and the original text is retrived as shown in above Fig.

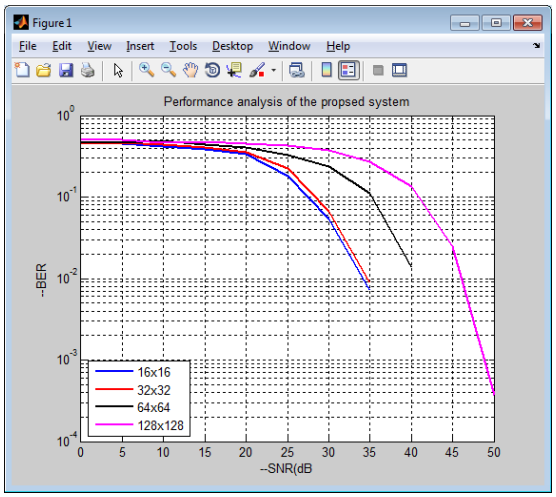


Figure 7: Performance Analysis of Proposed Method

Figure 7: Analysis: Now the next step is to analyse the performance of the received QR code for$16 \times 16$, $32 \times 32$, $64 \times 64$, $128 \times 128$. The above figure shows as the bits size increases BER also increases. So, our main Aim is to reduce BER and for $16 \times 16$ the BER has got reduced.

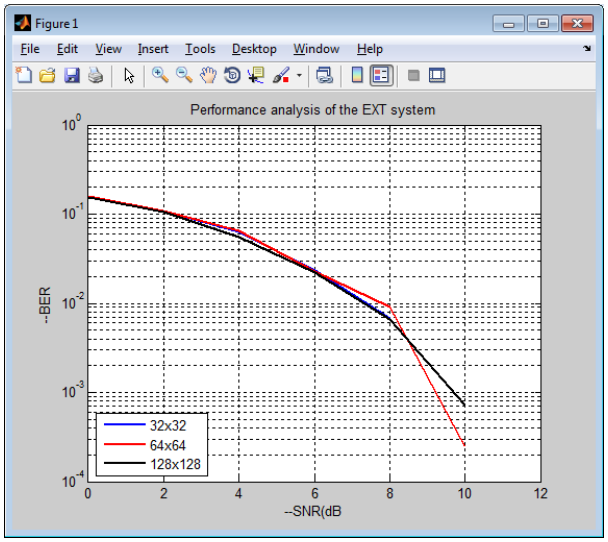


Fig.8. Performance Analysis of Extension Method

Fig.8. Analysis: The above performance is the extension of the proposed method. In this Discrete Wavelet Transform (DWT) is used to increase the SNR as well as to reduce the BER. The performance is Shown for $32 \times 32$, $64 \times 64$, $128 \times 128$. As compared to the proposed technique BER is much more less in the extension method

## 5. CONCLUSION

In this work a novel DWT based DPSK OFDM approach is proposed to design a framework for implementation of better handheld device communication to support various applications. By using DWT instead of fourier transform, we reduced the BER. Reduction in BER results into better performance in transmission data and picture blure reduces and we can received a cleared image of QR code. The performance is measured in terms of BER and SNR. As SNR increases BER decreases in DWT-OFDM instead of FFT-OFDM.

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