# A Novel Barcode Generation and ModulationTechniques

[1] D.Prasad

[1]Professor, Department of ECE, Ramanandatirtha Engineering College, Nalgonda, India

***Abstract:***

*There are numerous possible applications for a high data density barcode that can be easily photographed and decoded by mobile phones, but no such symbology presently exists. As a outcome, a new barcode was intended to exploit the low-pass characteristic of a camera phone channel and is offered as a means of enabling wireless optical communication with mobile phones.In this study, a new method for data modulation in 2-D barcodes is presented, and its performance is evaluated in contrast to other standard methods of barcode modulation. In this new method, orthogonal frequency-division multiplexing (OFDM) modulation is used together with differential phase shift keying (DPSK) over next to frequency domain elements.*

**Keywords***:Barcode, data transfer, differential phase shift keying, orthogonal frequency-division multiplexing (OFDM) modulation.*

## I. INTRODUCTION

As the information technology industry lasts to grow at a fast rate, digital communications have become widespread in every domain of life. The virtual world is ever-expanding.However, a considerable portion of business, advertising, and logistics depends heavily onphysical media for communication. Despite the prominence of digital devices and computers in the business world, paper continues to play a significant role. For this reason, methodsof interfacing documents and objects with digital formats and virtual databases can significantly increase efficiencies and enhance communication. Perhaps the most recognizable ofsuch methods is the barcode.

A barcode is a machine-readable representation of information displayed on a surface. Generally, barcodes use dark markings ona light surface to create a high and low reflectance that can be converted into binary digits.However, several techniques have diverged from the traditional encoding methods by using colour, as well as representations that are invisible to the human eye. Barcodes are readusing optical scanners, or decoded from images using the required software [1,9].The original one-dimensional barcodes encode several characters into a linear series ofbars. Because of their low data-density, these linear barcodes are used to simply link an itemto an existing database when scanned. Two-dimensional barcodes were developed in the mid-eightiesin order to encode all of the necessary information about an item into the barcode itself, asopposed to just its address in an existing database. Two-dimensional barcodes encode information along the vertical axis as well as the horizontal axis, while one-dimensional barcodesencode data in the horizontal direction only, with vertical redundancy.

Infact for machine readable digital data storing on productpackages or paper, barcode is a cost-effective and simplemethod. Even faster data transfer as pressing needs and therehave been many improvements with high reliability haveemerged on the original barcode design that was made. Forthese cost-effective codes as well as their application openeda new front by invention of HC2D barcodes in scenarios likestoring contact information which transfer more complexdata, URLs among other things, there have becomeincreasingly popular in which QR codes [2]. There can befound the performance of camera phone applications in thecomparison of 2D barcode in [3].

## II. RELATED WORK:

Moreover unlike the static paper, the LCD may display time-varying barcodes for the eventual transfer of streamsof data to the receiving electronic device(s) as depicted in Fig. 1.This knowledge has been applied in [4] where transmission ofdata between two cell phones through a series of 2D QR codesis studied, achieving bit rates of under 10 kbps for state of theart mobile devices.

Later the idea was further developed in [5] in which a computer monitor and a digital camera are used for transmission and reception with bit rates of more than 14 Mbps achieved in docked transmitter and receiver conditions over distances of up to 4 meters. However, this rate drops to just over 2 Mbps when the distance is increased to 14 meters.

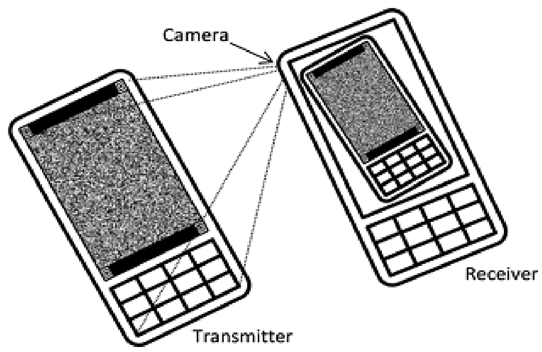


**Fig. 1. An Illustration of Transmission of Data Between Two Handheld Cameraphones Using A Sequence of 2D Barcodes.**

The higher performance of the future implementation is accomplished usinga more effective modulation and coding scheme for alleviationof image blur and pixel to pixel light leakage. The general ideais to use the inverse Fourier transform (IFT) of data like OFDMto modulate LCD pixels. Even though image blur and light leakagegreatly reduce the performance of QR decoders they have alimited effect on OFDM modulation. Additionally their performance deprivation is limited to known portions of the decodeddata. This previous knowledge on non-uniform error probabilitymay be used for adaptive error correction coding based on dataregion as in [5]. There is an increasing interest in design andimplementation of LCD-Camera based communication systemsas specified in [6]–[8]. This would require supplementarysurveys in determining optimal modulation and demodulationschemes for this type of innovative communications medium.

## III. PROPOSED SYSTEMDATA TRANSFER CAPACITY

The OFDM modulation uses orthogonal frequency subcarriers to transfer data and can restrain image blur, which is fundamentally a low pass filter, to high frequency components such thatlow frequency data bits are transmitted uncontaminated. This method requires high phase coherency to detect the data bits correctly. Thecurrent study extends this idea through additional modificationson the modulation scheme in a way to mitigate LCD-camera relative movements during the capture of a single frame, which outcomes in motion blur distortion on the captured images.

The required movement tolerance is achieved by puttingdata in phase differences of adjacent frequency componentsleading to a DPSK-OFDM scheme which would be calledsimply the DPSK method throughout this study. Observingthat any phase distortion due to motion blur would affectneighboring frequency components negligibly, data may betransmitted reliably even in the vicinity of high LCD, camerarelative motion. A diagram of the system envisioned is shownin Fig. 2. This method also eliminates the channel estimationrequirements resulting in lower processing power.

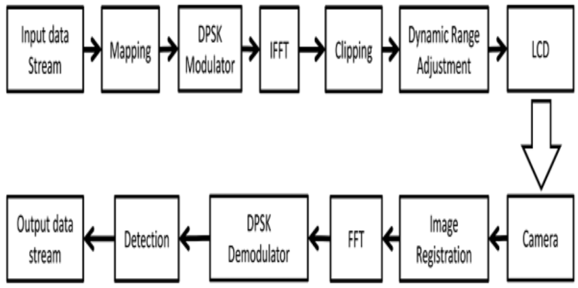


**Fig. 2. Diagram of The Algorithm Used for Data Transfer. Data Stream is Supposed to Include Source Coding and Error Correction Coding.**

To maximize data transmission rate, one should consider extracting maximum data from a single image shown on an LCDand then increase the rate at which consecutive frames will bedecoded.There are numerous issues distressing the amount of data thatcan be extracted from a particular LCD, some of themdepend on the LCD design itself and others on thecamera working as the receiver.

***Data capacity of an LCD*****:** It might be calculated by considering forinstance the maximum number of bits in a raw image as shownon the LCD. A display having the rows $M_D$and $N_D$ columns,showing a color image in $L_D$ channels and color bit depth of bits per channel,would have the maximum information of:

$$C_I = M_D \times N_D \times L_D \times B_D \; bits\ per\ image \ldots\ldots (1)$$

This is the maximum information that can be shown on the LCDon a single image due to the discrete nature of the data shown.

Awkwardly, our desired rate cannot be achieved due to the some restrictions as pronounced below:

### *A. Camera Limitations:*

A propelled camera could be deliberated as a device whichdigitally tests a 2D signal. For right testing ofpersistent housings in time, camera catch rate should be 2times the display restore rate ) unless there is asynchronization system set up to authorize the camerashade when the photo is stabilized on the showcase(accurately between packaging changes).

### *B. Power Limitations*

The limit of each correspondence channel relies on uponthe signal's force sent through that medium as anticipated by Shannon hypothesis, and

for this situation theforce distance and angle between camera and LCD(perspective distortion);
• camera and subject relative motion;
• out of focus lens;
• compression distortions;
• unwanted ambient light sources;

### C. *Finder Patterns*:

Proper demodulation of data requirespre-cise extraction of the modulated data from capturedimage and compensating for any perspective distortions.

### D. *Inter-Symbol Interference (ISI)*

When a barcode is printed on paper, a white pixel does not affect its neighboring black pixels provided that the print quality isgood and the resolution is high enough. On the other hand, whendata is shown on an LCD, light that is passing through whitepixels may leak into neighboring black pixels making them lookgray.

These nonlinear(undesirable effects) should be addressed to make sure the possibility of thealgorithm under accurate scenarios, while stabilizing the abilityfor attaining high data transfer rates

## IV. DPSK-OFDM

The main ideain resolving this problem is to interpret the barcode image as awireless radio signal for which ISI reduction techniques have already been proven successful. Solitary of the best and most possiblemodulation methods capable of deal with with severe conditionsin band limited communication channels is the so-called Orthogonal Frequency Division Multiplexing or OFDM.

### A. *Similarities of Barcode and Wireless RF Channel*

Consider taking a picture of this single row, in a band limitedchannel which has a combination of camera focus problems,resolution limitations, light leakage from white to black pixels,among other things. Moreover in a multipath channel in whichthe camera moves during image capture and mixes up the imageof several neighboring pixels, the resulting image will sufferfrom high ISI.

***Solution***:

To solve these problems in a time domain radiosignal, OFDM method is used to essentially divide the channelinto multiple orthogonal low bandwidth channels and the lowrate data is sent into these channels in parallel.

a) Here the 1D data the inverse Fourier transform is used for displaying the data instead of using the PAM modulated process, where Hermitian symmetry conditions should be met to have real-valuedoutputs.
b) As a result, most artifacts only affect the high frequency components leaving low frequency components intact for datatransmission.

When using OFDM for transmission of data as images, all thechannel equalization computations should be based on a singleOFDM frame due to the independent channel response betweensubsequent frames, unless the frame rate is very high. In facteach frame is distorted by LCD-Camera relative motion duringits own capture time.

***Solution***:

To mitigate this problem the phase difference between adjacent elements is used to convey data.

a) Using DPSK modulation earlier to applying the inverse Fourier transform in OFDM modulation, data would not have to be stored in the absolute phase of the received elements
b) But rather in its phase difference to the neighboring element, which eliminates the requirement for channel estimation and
c) Equalization if thechannel response does not vary abruptly between adjacent subcarriers.

### B. *Transmitter*

One of the benefit of using OFDM is its effective computation method which uses the Inverse Fast Fourier Transform(IFFT) to modulate input data into orthogonal frequencies. Themodulated signal should be real-valued in order to be shown onan LCD, so the input to the IFFT algorithm should have Hermitian symmetry. This requirement is shown in the followingequation:

$$T(M-m, N-n) = T(m,n)^* \ldots\ldots\ldots\ldots..(2)$$

where $0 \le m < M$ *and* $0 \le n < N$, and $*$ denotes the complex conjugate operator.

Fig. 3 shows the elements relationshipin order to have a real-valued IFFT for matrix. In this configuration, only regions 1 and 2 are used for data transmissionindependently, and regions 3 and 4 are calculated accordingly tohave a real-valued IFFT. Moreover, the symmetry requirementsfor elements that have been deliberately set to zero would beinevitably satisfied.TheIFFT of this matrix would have real-valued output on display. Bended linesshow location of complex conjugate pairs.

#### 1) *Constellation Mapping*:

The input data is decomposedinto 2-bit symbols. Each symbol is converted to acomplex phase by the following rules:

$$11 \rightarrow e^j \frac{1\pi}{4}, 10 \rightarrow e^j \frac{7\pi}{4}, 01 \rightarrow e^j \frac{3\pi}{4}, 00 \rightarrow e^j \frac{5\pi}{4}$$

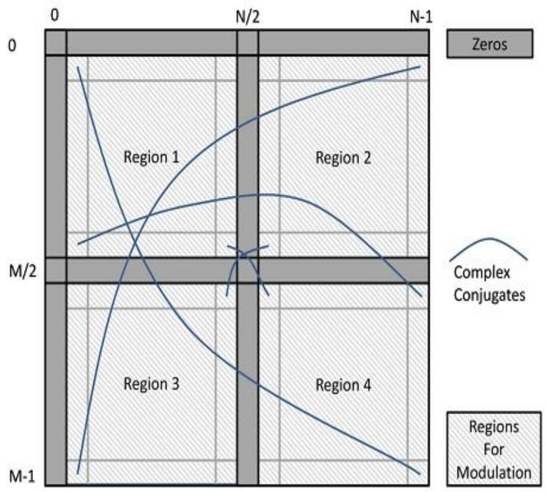


**Fig. 3. Hermitian Symmetric Matrix Used for DPSK-OFDM Modulation.**

Therefore the first bit modulates the real component and thesecond bit modulates the imaginary component of the phase foreach data symbol.

These symbols are placed in a$\frac{M-2}{2}$, $\frac{N-2}{2}$matrix **S** which contains the absolute phase elements that aregoing to be modulated using DPSK.

*2) **Inverse FFT:***

Considering is the frequency domain representation of the signal, the IFFT is applied on it to have thetime domain signal referred to as $\mathbf{D}_i$.This signal wouldhave zero mean because, so it should be adjusted in orderto use the full dynamic range of pixels.

*3) **PAPR Adjustment:***

$\mathbf{D}_i$ is a real-valued 2D signal withhigh peak to average ratios.The most practical methods would besoft clipping of the signal in which a threshold level of$\mathbf{A}_{max}$based on signal average power level is set such that:

$$Clippratio = \frac{A_{max}}{\sqrt{P_{avg}}} \ldots\ldots\ldots\ldots(3)$$

Where$P_{avg}$ is average power per element in the OFDMsignal before clipping. Any components with higheramplitudethan $A_{max}$ are consequently clipped to $A_{max}$ resulting in a 2D matrix $\mathbf{D}_c$

*4) **Amplitude Adjustment:***

The pixel levels in the PAPR adjustedimage need to be transformed into LCD dynamic range levelsfor efficient utilization of transmission power.

*5) **Finder Patterns:***

Proper demodulation of data requires precise extraction of the modulated data from captured image andcompensating for any perspective distortions.

A sample 128 X 128 image generated by the precedingmethod is shown in Fig. 4 as it would be shown on the LCD ofthe transmitting device.

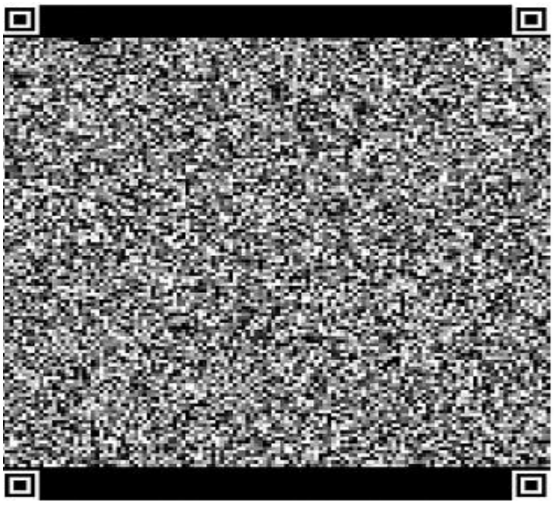

**Fig. 4. Final Image Shown on the LCD After Applying the DPSK-OFDM Modulation Algorithm.**

*6) **Cyclic Extension:***

OFDM systems require cyclic extension to prevent inter carrier interference (ICI) [10]. To be sufficient, the length of theadded cyclic extension must be more than the time spread of the channel.

*7) **Receiver:***

After displaying the generated image of Fig. 4, thereceiver uses its camera for sampling and recordkeeping theacquired image so that a fairly acceptable copy of iscreated at the receiver end. The effects of interference,noise and distortions encoun-tered in this step areaddressed in the simulation section. To obtain thetransmitted data successfully, the following steps should betaken into consideration at the receiver end

*8) **Image Capture:***

Digital camera and display systems have alimited refresh rate which tends to be more than 23 Hz fordifferent standards.

*9) **Image Registration:***

The first step in processing thecaptured image is to extract the displayed image frombackground which depends on predefined finder patternsput into the image.

*10) **FFT:***

Applying Fast Fourier Transform on theregistered image results in frequency domain datawhich is comprised of the differential phase modulatedelements stored in $\mathbf{R}_f$matrix.

*11) **DPSK Demodulation:***

Theoriginal constellation mapped data can be extractedusing phase differences between respective elements,but first data corresponding to regions 1 and 2should be concatenated together to form matrixcorresponding to the transmitted matrix T.The resulting$\mathbf{R}_d$ would be a distorted copy of intransmitter path.

*12) **Detection:***

Now that the phase differences have beenex-tracted, each input bit may be calculated using theconstellation map of the transmitter.

*13) **Error Correction:***

Barcode employs error correction to generate a series of error correction codeword which are added to thedata codeword sequence in order to enable the symbol to withstand damage without loss of data. There are four userselectable levels of error correction, as shown in Table 1, offering the capability of recovery from the followingamounts of damage.

**Table 1 Error Correction Levels**

| Error Correction Level | Recovery Capacity %( approx.) |
|---|---|
| L | 7 |
| M | 15 |
| Q | 25 |
| H | 30 |

Error Correction can be implemented by using the division circuit as shown in Fig .5.

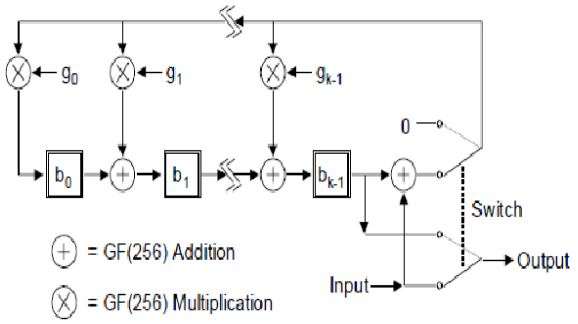


**Fig.5 Error Correction codeword Encoding Circuit**

The registers b0through bk-1 are initialized as zeros. There are two phases to generate the encoding. In the first phase, with the switchin the down position the data codeword are passed both to the output and the circuit.The first phase is completeafter n clock pulses. In the second phase (n+1 ... n+k clock pulses), with the switch in the up position, the errorcorrection codeword k-1 ... 0 are generated by flushing the registers in order while keeping the data input at 0.

## V. CONCLUSION

Itwas revealed that QPSK-OFDM modulation has serious inadequacies in the alleviation of camera LCD movements wherethe phase of each element deviations constantly. On the otherhand, addition of a differential phase modulator before OFDMto modulate the data stream into phase differences of adjacentelements (DPSK-OFDM) sources the motion effect to progressively deteriorate because of its steady alteration from element to element, subsidizing to a small abnormality from the ideal phase inthe received signal.

## REFERENCES


[1] R. Adams. Bar Code 1: 2 Dimensional bar code page. http://www.adams1.com/pub/russadam/stack.html, 1995. Accessed 19 February 2008 [Online].

[2] Information Technology—Automatic Identification and Data Capture Techniques—QR Code 2005 Bar Code Symbology Specification, ISO/IEC 18004:2006, 2006.

[3] H. Kato and K. Tan, ―Pervasive 2d barcodes for camera phone applications,‖ Pervasive Comput., vol. 6, no. 4,pp. 76–85, Oct. 2007.

[4] X. Liu, D. Doermann, and H. Li, "Vcode-pervasive data transfer usingvideo barcode," IEEE Trans. Multimedia, vol. 10, no. 3, pp. 361–371,Apr. 2008.

[5] S. D. Perli, N. Ahmed, and D. Katabi, "Pixnet: Interference-freewireless links using LCD-camera pairs," in Proc. MobiCom, 2010, pp.137–148.

[6] J. Memeti, F. Santos, M. Waldburger, and B. Stiller, "Data transferusing a camera and a three-dimensional code," Praxis der Informationsverarbeitung und Kommunikation, vol. 36, no. 1, pp. 31–37, 2013.

[7] C. Pei, Z. Zhang, and S. Zhang, "Softoc: Real-time projector-wallcamera communication system," in Proc. ICCE, Jan. 2013, pp.100–101.

[8] S. Kuzdeba, A. M. Wyglinski, and B. Hombs, "Prototype implementation of a visual communication system employing video imagery," inProc. CCNC, 2013, pp. 184–189.

[9] Rosistem Bar Code. Barcode Education. http://barcode.ro/tutorials/barcodes/index.html, 2003-2008. Accessed 19 February 2008 [Online].

[10] R. Morrison, L. Cimini, and S. Wilson, "On the use of a cyclic extension in OFDM," in Proc. 54th IEEE Veh. Technol. Conf., 2001, vol. 2,pp. 664–668.