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Performance in Characteristics Rayleigh Channel within DWT- OFDM with DAPSK Modulation for High Speed Communication

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ABSTRACT

The advantages for using the OFDM system when it convert the wideband signal into narrowband signals for parallel transmission. And in the same time using DWT which captures both location information (location in time) and frequency that is temporal resolution as advantages over DFT. So that can using Rayleigh channel within their specification underlying DWT_OFDM system with DAPSK modulation. Using matlab simulation for this mode in this paper, it has produced a good performances in impulse response, frequency response, multipath channel and Doppler spectrum. Through them can provide a good narrowband fading which has minimum ISI & ICI and a wide variety of communication services such as high speed data.

Keywords-- Matlab, ISI, ICI

I. INTRODUCTION

With OFDM technology,the subcarriers is used which as multiple carriers and a sub-band is obtained as the frequency band occupied by the signal carried by a subcarrier. Achieving orthogonality by OFDM in both frequency and time domains. OFDM has robustness against multipath fading which consider the most attractive for it, so therefore it can suitable for transmit data over frequency selective channels without the need of a complex time-domain channel equalizer or time dispersive [1].

Depending on the channel quality of individual sub-bands data rates can be implemented on different subcarriers and different modulation formats. OFDM enables contiguous bandwidth for operation is not required and higher spectral efficiency and bandwidth-on-demand technology[2].

The signal at different frequencies with different resolutions is called Wavelet transforms (TW) [4].

Allowing design of a communication system with certain specific properties whenWavelet transforms can be thought of as a generalized Fourier Transform[3]. WT has powerful advantage, it can provide relatively poor frequency resolution and good time resolution at high frequencies while poor time resolution at low frequencies and good frequency resolution[4].

1.2 DWT

Breaking up of original signal into shifted and scaled is analysis of Wavelet that called the mother wavelet[9]. A waveforms are non-zero for a limited period of time that are small oscillatory called wavelets when satisfying certain mathematical condition. That is, the wavelet transform has advantages such as high localization in frequency and time domain and can considering it to be wavelet diversity. For their important feature as overlapping it's symbols both in time and frequency, enables it a high spectral efficiency [5].

As known, a definition of the basis function of the discrete Fourier transform (DFT) is a sinusoid but the DWT their basis is a set of function which are defined by recursive function[7]

$\psi_{j,k}(t) = 2^{j/2}\psi(2^j t - k)$………………(1-1)

where k is translation in t,2^j is the scaling of t and $2^{j/2}$ maintains the L^2 norm of the wavelet at different scales. So can be represented by the series any signal in $L^2(R)$ as

$f(t) = \sum_{j,k} a_{j,k}\,\psi_{j,k}(t)$…………………(1-2)

where setting of coefficients$a_{j,k}$as the two-dimensional is called the DWT.

In the sense of DWT, the wavelet is an orthogonal function which by it being applied to an infinite group of data. Thus can be formulated DWT decomposition equation such as[10].

$DWT(m,k) = \frac{1}{a}\sum_{n=0}^{N-1} s(n)g\left(\frac{k-b}{a}\right)$…………………(1-3)

Where $b = na_0^m$, $a = a_0^m$, N is number of the windowed signal, the mother wavelet is $g(.)$, b and a are called the transition and scaling parameter, respectively, while m is the DL(decomposition level) index.

Different symbol length and different bandwidth with subcarriers can create with wavelet transform. A decrease(or increase)of bandwidth is bound to an increase(decrease)of subcarrier symbol when each subcarrier has the same time-frequency plane area. So creating a multirate system can be achieved within characteristics of the wavelets. Supporting multiple data streams that must system by a feature is favorable for systems for a communication perspective[8].

1.3 DWT-OFDM SYSTEM

The radio channel impairments robust against the high speed data streams is made with OFDM. In the multipath fading environment, OFDM is an efficient technique to handle large data rates which causes intersymbol interference (ISI).A large number of overlapping narrowband subcarriers are transmitted parallel within the available transmission bandwidth which are orthogonal to each other[11].

Wavelet transform based OFDM is used different number subcarriers and an oversampling factor of two. Since the DWT has a families from type DWT that through them such performance can be further enhanced. The trade off in general between the performance and the complexity of the wavelet implementation[5].

An efficient approach to replace FFT in conventional OFDM systems is DWT based OFDM. Due to decreasing the bandwidth wastage, by removing the use of cyclic prefix, DWT is employed and also by the use of wavelet transform the transmission power is reduced. In the same time, obtaining better The spectral containment of the channels in DWT-OFDM is than FFT-OFDM[11].

The modulated signal is transmitted using vector transposing and zero padding in wavelet based OFDM. As known, the DWT is highly efficient and flexible method for decomposition of signal[11].

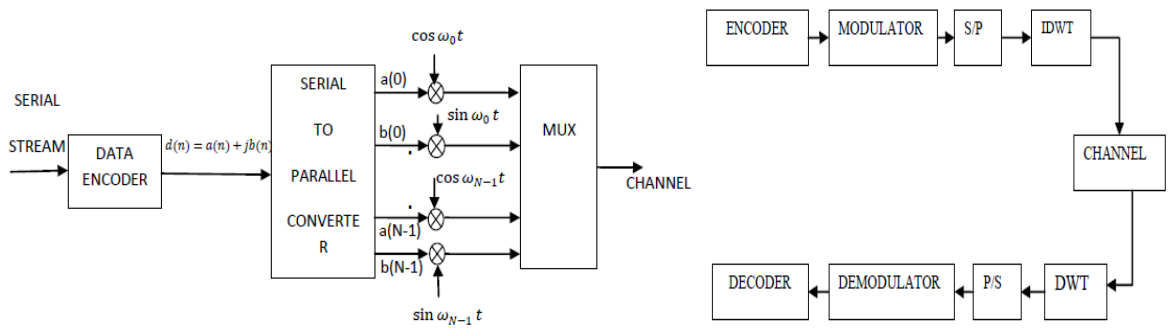


Fig1-1in the left represent the OFDM modulator & the right represent encoded DWT-OFDM

The Figure above represents the left part modulator OFDM and the right part where represents the based DWT-OFDM system. Whereas from figure is shown that subcarriers within OFDM had been orthogonality for each of them and they are converted from series to parallel. Due to persist the transform DWT which needs this converting in their inputs for both in the receiver and transmitter to map symbol convent the suitable technique modulation. Therefore, can express the equation for this based as[11]

$s(t) = \sum_{j \leq J} \sum_k w_{j,k}(t)\psi_{j,k}(t) + \sum_k a_{J,k}\varphi_{J,k}$ ....(1-4)

These carriers are relying the orthogonality on scale index(j) and time location (t) . considering the DWT-OFDM implementation complexity is less than FFT-OFDM due to the waveletcarriers exhibit better time-frequency localization than complex exponentials[11].

1.4 DAPSK (DIFFERENTIAL AMPLITUDE PHASE SHIFT KEY) MODULATION

This type of modulation considers as high level modulation. It combines between two types of modulation amplitude shift key(ASK) and phase shift key(PSK) in order Achieving better performance and a higher band efficiency[14].

No equalization and no time-consuming channel estimation is necessary, in differential modulation and demodulation, can including within using DAPSK modulation[12]. Reduction of the computational complexity that becomes proportional to log (M) obtains using especially for high-level DAPSK [13].

This technique can be expressed their mapping into complex value as equation below[15]

$S_k = r_k exp(j\Delta\varphi_k)$.................................(1-5)

where $\Delta\varphi_k$ and r_k represent phase transition factor and amplitude transition factor.

Decreasing the complexity of HF communication systems can be a feasible approach with the64-DAPSK modulation scheme [14].

1.5 RAYLEIGH CHANNEL

The received signal will appear as a pulse train when it is transmitted over a multipath channel that each pulse in the train corresponding to a distinct multipath component or the LOS component associated with cluster of scatterers or a distinct scatterer. The time delay spread that due to the received signal is an important characteristic of a multipath channel. The time delay between the last received signal component and the arrival of the first received signal component (multipath or LOS) equals delay spread associated with a single transmitted pulse. There is little time spreading in the received signal when the inverse of the signal bandwidth is large compared to delay spread. there is significant time spreading of the received signal if the delay spread is relatively large that can lead to substantial signal distortion[17].

The time-varying nature is another of the multipath channel which arises due to either the receiver or the transmitter. Therefore the location of reflectors will change over time that give rise to multipath in the transmission path. Thus, corresponding to each pulse, we will observe changes the number of multipath components, the amplitude, and delays when we repeatedly transmit pulses from a moving transmitter. However, due to destructive and constructive addition of multipath components these changes occur over a much larger time scale than the fading associated with a fixed set of scatterers[17].

When we have the next data such as f_c which represents carrier frequency , $x_b(t)$ which mean the baseband signal and $x(t) = \Re\{x_b(t)e^{j2\pi f_c t}\}$ that could be consider the transmit bandpass signal. Thus, the receiver through multiple paths is received the transmit signal where the n^{th} path has delay $\tau_n(t)$ and an attenuation $\alpha_n(t)$. so that can express equation for received signal as[18]

$r(t) = \sum_n \alpha_n(t)x[t-\tau_n(t)]$ ……………………………………………………(1-6)

Subsuiting the transmit bandpass in the received signal yield

$r(t) = \Re\{\sum_n \alpha_n(t)x_b[t-\tau_n(t)]e^{j2\pi f_c[t-\tau_n(t)]}\}$ ……………………………….(1-7)

The received signal has the baseband equivalent as

$r_b(t) = \sum_n \alpha_n(t)\, e^{-j2\pi f_c \tau_n(t)} x_b[t-\tau_n(t)] = \sum_n \alpha_n(t)\, e^{-j\theta_n(t)} x_b[t-\tau_n(t)]$ (1-8)

where the phase of the $n^{th}$is $\theta_n(t) = 2\pi f_c \tau_n(t)$. So that the response impulse express as

$h_b(t) = \sum_n \alpha_n(t)\, e^{-j\theta_n(t)}$ ……………………………………………………..(1-9)

The magnitude of signal will vary often and in fade, or a random manner, when it has passed through medium or a transmission channel, according a Rayleigh distribution – the radial component of the addition of two uncorrelated Gaussian random variables, so that consider that Rayleigh fading models[1].A sensible model for ionspheric and tropospheric signal propagation as well as the effect of heavily built –up urban ambience on radio signals is observed Rayleigh fading. The scatter for the radio signal before it finally reaches the receiver when there are many objects in the environment is reasonable model as Rayleigh fading that presence of a dominant line of sight.the impulse response of the channel can be modeled well as a Gaussian process when there is sufficiently too much scattering, according to the central limit theorem[16].

The process will have phase evenly distributed between 0 and 2π and zero mean. therefore be known as a Rayleigh distributed one that is the envelope of the channel response.The random variable R will have a probability density function[1]

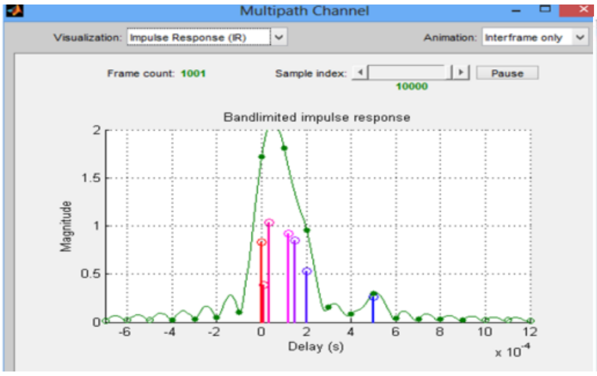
$P_R(r) = \frac{2r}{\Omega}e^{-r^2/\Omega}, r \geq 0$ where $\Omega = (R^2)$……………………………………(1-10)

II. RESULTS & DISCUSSION

We can be describe the result for using MATLAB simulation to Rayleigh channel within DWT- based OFDM system with DAPSK modulation when the channel visualisation is opened at start simulation as:

From Fig.1.a by stems we can be represent the multipath response that each corresponding to one multipath. The component with the largest delay value is shown in blue, the component with the smallest delay value is shown in red. In same time for larger delays become more blue, for components with intermediate delay values, due to these components are shades between blue and red.

The channel impulse response is illustrated in Fig.1.a as a snapshot of the channel visualization tool that their amplitudes are time-varying due to the fading. as specified in PathDelays should be the vertical lines correspond to the delays of the actual channel impulse response. Corresponding to the delays of the transformed along the solid curve that is the solid points should be symbol-spaced channel impulse response has been the 14 delays in the Bandlimeted symbol-spaced channel impulse response comparing to the non-symbol-spaced one which has just 7.



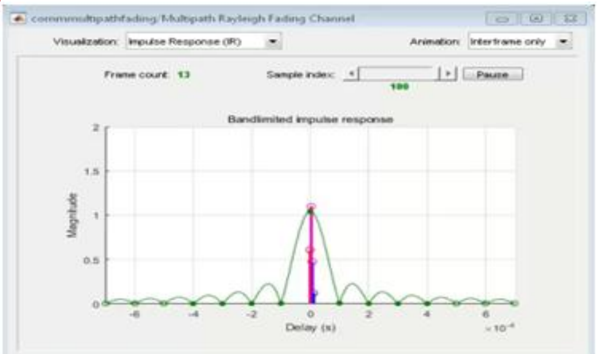
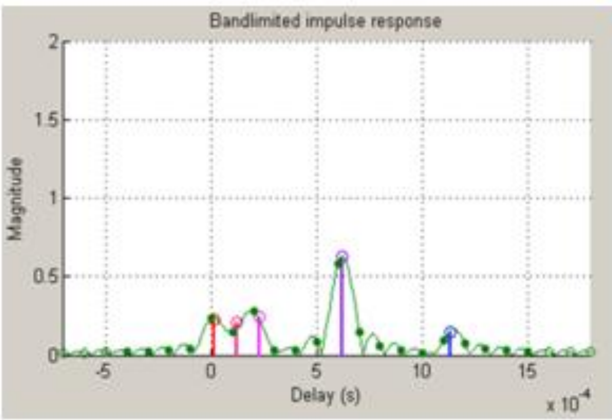


Fig.1.a Impulse response for DWT-OFDM system with DAPSK modulationtechnique
Fig.1.b Impulse response for BPSK modulation

From figuers Fig1.a,b,c and d, we have more figuers impulse response for differents techniquel modulation that have their envelopas the green curve represents the bandlimited channel response, so the results of convolving the multipath impulse response is whose response as a since pulse of duration T which equal to the signal's sample duration, thus has very small intersymbol interference (ISI)which depend upon span it's channel's delay. In other hand, for obtaining necessitating a reduced symbol rate for a given bandwidth for a given symbol rate (or a large bandwidth). Therefore we get more detailed information about convolution and delay for large bandwidth. The transition in the frequency domain has to be more gradual when the penalty for more rapid pulse roll-off in time is done.

In contrast, By the rate 1/T can sampled the channel filter response that represent with the solid green circles. The convolution of the discrete-time FIR with the input signal (sampled at rate 1/T) is presented the output of the channel filter. But sample values not captured in the channel filter response are the hollow green circles that used for processing the input signal.



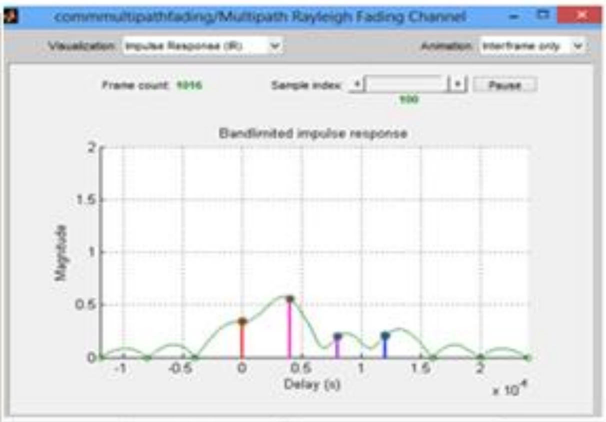
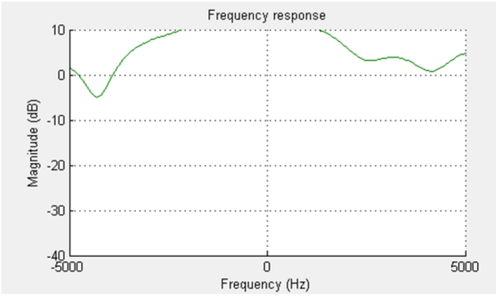


Fig.1.d Impulse response with DPSK modulation

Fig.1.c Impulse response for OFDM system with QPSK modulation

Due to using Wavelet transforms which can be applied, such as a data cube, to multidimensional data. As mentioned can applying the transform step by step so the first dimension is done, then to the second, and so on. As well as the DWT captures both location information(location in time) and frequency.

So that from introduced above, can be obtained the bandwidth of data significantly does not exceed the channel's coherence bandwidth which be reasonably that channel is flat and also using OFDM which has specification can transform a frequency-selective fading channel of bandwidth into N orthogonal flat fading. That can be seen



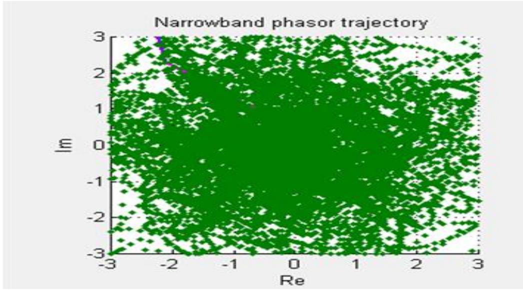
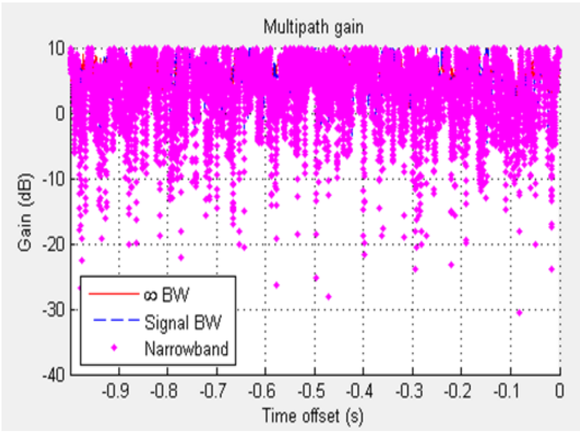


Fig.2Frequency response for DWT-OFDM system with DAPSK modulation
Fig.3Narrowband phasor for DWT-OFDM system with DAPSK modulation

From figures Fig.2 &Fig3, so thefirst illustrates frequency response which it show the state of flat clarity in Fig.2 and Fig.3 indicates a green color that mean it's narrowband. Thus why it pass through zero, it should be deep fading.In contrast, again we could improved the narrowband flat fading. Due to the narrowband it mean the span of delays of multipath channel much smaller than a sample period, so that give us improve for the bandwidth much smaller coherent bandwidth which has good symbol rate.



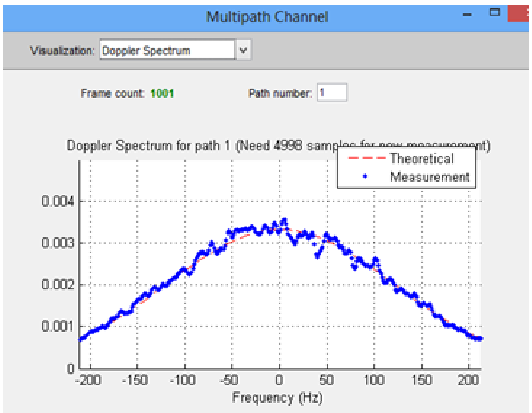


Fig.4 Multipath gain for DWT-OFDM system with DAPSK modulation
Fig.5 Doppler spectrum for DWT-OFDM system with DAPSK modulation

From Fig.4 which shows the group gains for DWT-OFDM system with DAPSK modulation by three signal bandwidths for multipath channel. Here, there are appeared us by three dots different colors a magenta dots(it is the magnitude of the narrowband phasor), a dashed blue line(it is the sum of the magnitudes of the channel filter impulse response samples) and a solid red line(it is the sum of the magnitudes of the channel filter) represent the narrowband, current signal bandwidth and infinite bandwidth, respectively. Mostly, the variability of this signal fading or multipath gain but such as signal bandwidth is increased when it decreases, therefore multipath components become more sensible. So too here the signal bandwidth seem to be narrowband due to the curve roughly follows the narrowband.

As well as, from Fig.5 should be indicated two curves for Doppler spectrum for DWT-OFDM system with DAPSK modulation, a red color is a theoretical Doppler spectrum which used to determine a Doppler filter response and used for multipath channel called the Jakes spectrum. In mean while, the blue dots represents the second Doppler spectrum which is to regulated by measuring the power spectrum of the multipath fading channel that by it can generates path gains. So that, due to a good approximation between both curves in this state therefore this model can considered has generated enough fading gains to obtain a sensible illustration of the channel statistics which give us a good opportunity for determine average BER of a communications link with a multipath channel.

III. CONCLUSION

When the DWT based OFDM within DAPSK scheme modulation is used and passed through medium such as Rayleigh channel seem to be from analysis results simulation using MATLAB more than performances. One of them obtains channel response against ISI and better bandwidth efficiency. Then in the same time , obtaining the bandwidth of data significantly does not exceed the channel's coherence bandwidth which yield better flat fading also persist OFDM. Due to narrowband is obtained which enhanced the flat and also good symbol rare. Though the multipath components become more sensible when this technique is used. From Doppler spectrum, is shown, obtains a sensible illustration of the channel statistics which give us a good opportunity for determine average BER of a communications link with a multipath channel. In contrast, those performances could induced the high sensible ability in using high speed communication.

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