CHANNEL ESTIMATION IN OFDM SYSTEMS

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Abstract : **The efficiency of spectrum and data rate in communication has improved a lot in recent years. There are many advanced technologies like 3g , lte ,4g, digital televsion has been developed using OFDM and channel estimation techniques. Communication system uses radio waves as transmission which are multipath fading ,due to which it causes problems like ISI (intersymbol interference). To remove ISI we need to use an equalizer .this equalizer works with channel estimator to remove ISI and gives a clean and noise free output .channel estimator with the help of equalizer checks the output with transmitter and produce noise free and with minimal distortion free output.**

IndexTerms **– Channel Estimation ,OFDM .**

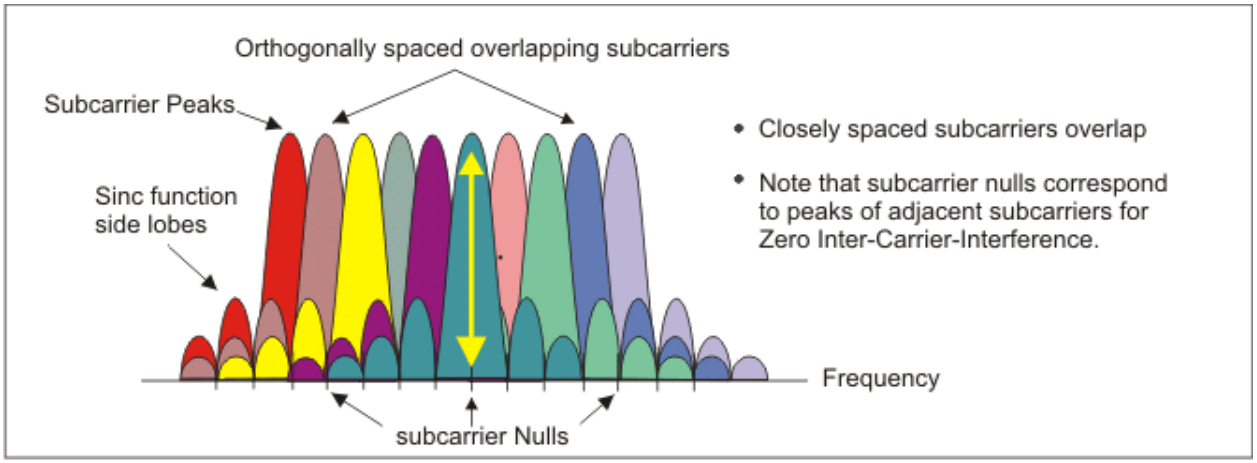
Keywords :

AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
CDMA	Code Division Multiple Access
FDMA	Frequency Division Multiple Access
ISI	Inter Symbol Interference
LSE	Least Square Estimation
MMSE	Minimum Mean Square Estimation
OFDM	OrthogonalFrequencyDivision Multiplexing
PSK	Phase Shift Keying
QPSK	Quadrature Phase Shift Keying
SNR	Signal to Noise Ratio
TDMA	Time Division Multiple Access
VLSI	Very Large Scale Integration

I. INTRODUCTION

OFDM(orthogonal frequency division multiplexing):

Current modulation techniques or scheme uses OFDM .OFDM has become the basic block of these techniques like 4g, 3g ,WLAN,LTE.OFDM is basically the extension of single sub carrier modulation with multiple sub carrierwithin the same channel ,it is basically a multi carrier modulation scheme used in various technologies nowadays.OFDM uses larege number of space orthogonal carriers and send them in parallel to each other, rather than transmiiting a high data rate stream through channel .every subcarrier in OFDM is modulated with some modulation scheme like qpsk,bpsk,msk etc . at very low rate .
OFDM is a type of frequency division multiplexing.In FDM technique various schemes are formed in separate channels on frequency.these channels are separated by guard intervals or band which helps to reduce interferences between other adjacent channels. These guard intervals minimize or decrease the delay spread and ISI .



OFDM Signal Frequency Spectra

Above figure,explains the concept of OFDM signal and its relationship between frequency and time

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Frequency domain:

In this domain ,all the subcarriers are indpendentle modulated with complex data , after modulation of the carriers with data inverse fast fourier transform is applied on the frequency domain carriers which produce OFDM signal on time domain . each subcarriers in frequency domain represented as sinc function with side lobes

Time domain:

In this domain ,we introduce guard bands /intervals between evry symbols to overcome the problem of inter symbol interference on the receiver end .thisw problem is caused dur to multi path delay spread in the channel.Multiple symbols combine together to form an OFDM signal .and then FFT is performed at the output end to recover orginal data bits.
At orthogonal frequencies , the carriers are all in line with the nulls of other carriers .so at the orthogonal frequency , overlapping of energy do not intervene with ability of the system to recover the original signal .

The main advantage of using OFDM signals is that it allows more carriers in the same bandwidth with an increase in energy spectral density.

➢ WHAT IS CHANNEL ESTIMATION AND WHY IS IT CRUCIAL ?

As we know , in present day scenario the scene is that the need for high speed data transmission and for different multimedia services specially for mobile communications in modern mobile wireless system are extremely expanding . As a result , for example, UMTS (universal mobile telecommunication systems) , third generation partnership project (3GPP), have been established to overcome these problems , due to user mobility problems like channel fading and Doppler effects very normal. TIME-VARIANT CHANNEL ESTIMATION is used to overcome this fading and dopler shift effect and improves its process
So basically , to improve the performance of the system we use channel estimation technique,recent technologies like 4g and lte are some great examples .OFDM symbols are used for estimation of channel with the help of these symbol channel estimation is done .to provide high data rate in wireless system we use channel estimation technique like in 4g

- IT IS CRUCIAL BECAUSE : When we take into consideration , the wireless channel which changes with time , caused by the movement of transmitter and receiver, then the CHANNL ESTIMATION technique comes into action . MULTIPATH INTERFERENCE comes into action due to reflections , refractions from surroundings like buildings, hills , objects , etc in mobile wireless communication , then it becomes difficult for the system to maintain and provide stable , reliable high data rate transmission at the receiver to accurately estimate the time varying channel.

- Moreover , wireless mobile systems which is used to provide all the latest recent services including data communication, audio and video call services with best quality possible requires the need for an CHANNEL ESTIMATOR for providing best of all the above services .

- And so the learning and understanding of the channel impulse response (CIR) in mobile wireless propogation channels in channel estimator is a boon to acquire all the knowledge and information for maintaining , testing and planning of future wireless communication systems .

Fourth Generation Wireless Systems

In spite of the fact that transporters are hesitant to examine 4G, merchants are continually mapping eventual fate of 4G frameworks. It is as yet 10 years away (at any rate), however 4G is as of now a major theme of discourse in secret. Fundamental focal points of 4G are its range advancement, arrange limit and quicker information rates, nonetheless, bearers are as yet hesitant to examine 4G, either in light of the fact that they decline to take an open position on it when 3G move outs still are unfulfilled, or on the grounds that they are trying to claim ignorance. In any case, bearers before long will find that 4G isn't leaving. 3G frameworks are insufficient for some, administrations like information exchange between remote telephones or sight and sound. Gear sellers are meeting up to speed the appropriation of OFDM, which will be a piece of the 4G set of models.

TECHNIQUES USED IN CHANNEL ESTIMATION

The following are the channel estimation techniques depending upon the method or the approach used

Training based estimation	Blind channel estimation	Pilot based estimation
LS,MMSE Algorithm	STBC,OSTBC Algorithm	Using pilot symbol

1.Method based on the pilot symbol
2.Blind estimation
3.Synchronization
4.Reserviour computing

1.**Method based on the pilot symbol**
In the data ..we select some reference points named as the pilot symbol ..so basically pilot symbol means a certain point of data with know coordinates used at the transmitter and receiver of a communication system
Also…the pilot based method can be further divided into two parts as block types or comb types
Block types-pilot symbol are inserted into all frequency bits ,within the periodic intervals of OFDM
Comb types-pilot tones are inserted into each OFDM symbol with in a specific period of frequency bits
Also the addition of the guard symbol or the cyclic prefix with appropriate parameters can be a part of the channel estimation technique
Training based method In channel estimation uses the algorithm like least square and minimum mean square error .

2**. Blind channel estimation**
When the input is not provided/available at the receiver end ..the channel estimation is called as the blind channel estimation
However blind channel estimation used only the deterministic and stochastic properties of the symbols present in the message signal ,in semi-blind channel estimation it used the statistical properties of the surrounding data symbols present in a message signal .

3.**Synchronization**
Based on this technique ..there comes three methods as timing synchronization ,carrier synchronization
Timing synchronization
Timing synchronization includes the channel synchronization and the symbol synchronization ,the actual purpose of this is to find the first or the reference position within a specific timeline .
Once completing on this ,we can start for the precise symbol synchronization , called as symbol tracking , concept of autocorrelation and power calculations of the received signal are being used .
Carrier synchronization
It is further divided into integer frequency offset and fractional frequency offset detection
The fractional frequency offset detection directly uses the correlation characteristics of the training sequence in a time domain provided the correlation peak is sharp and sidelobe is zero .

4.**Using reservoir computing**
In order to bypass the gradient descent methods of the training algorithms for RNN(recurrent neural network),the reservoir computing approach generates a rnn with random synaptic weights called as the reservoirs
An input layer of the neurons provided to excite the reservoir through the weighted input connections .the output of the neurons ,provides teacher forced output to the reservoir through the weighted feedback connections .based on this input stimuli and the feedback of the teacher forced outputs the reservoir is trained to generate the weighted connections .
The main purpose of this to determine the weights of the readout connections from the reservoir used as a liner regression technique .

Which is the best technique ?

So the baseline is each and every technique comes with benefit and drawbacks to ..the main point is we should take certain actions to reduce the drawbacks for maximum outputs and least factors like channel fading ,signal to noise ratio(SNR),Inter channel interference(ICI),Inter symbol interference (ISI).
The technique using the pilot symbols ..when provided the best of using algorithm can bring us maximum outputs with lesser complexity ,low inter channel interference and other parameters too

THE KEY IS MODIFIY THE LS AND MMSE ALGORITHMS
The least square and minimum mean square error when provided a specific taping of say atleast 10 ..they reduces the drawbacks of using pilot channel estimation making it much reliable ,suitable and preferable technique
When the algorithms are provided a tapping of say 10 they are called as the LS10 and MMSE10.

BLOCK DIAGRAM DESCRIPTION:

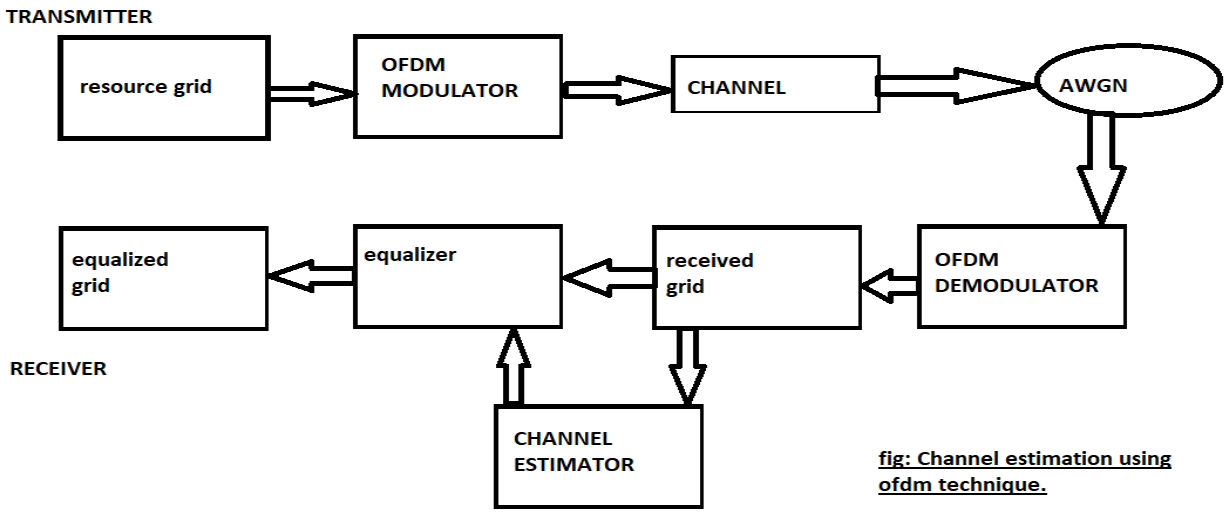

fig: Channel estimation using ofdm technique.

Resource grid: we use resource grid as populated resource grid which represents subframes containing data .

OFDM modulator: this resource grid passed through OFDM modulator which encodes digital data frames on multiple carrier frequencies.
Channel: now this modulated signal or data is passed through the channel.

AWGN: AWGN is additive white Gaussian noise which is added in the form of channel noise in the signal before it enters the receiver side. AGWN is basically used to copy the effects of random sources that are occurring. It maintains uniform power across the frequency band

OFDM demodulator: now the incoming signal is decoded again the resource grid containing data frames can be generated back with minimal error .

Received grid: after demodulation grid is constructed back nd data frames saved . this received grid contains complex channel gains ,and channel noise .

Channel estimator: now the noised grid is passed on to channel estimator . In this we use pilot symbols using the knw pilot symbols used in transmission we can equalize the effect.

Equalizer: equalizer equalize the effect of noise and gains .

Equalized resource grid : equalized resource grid contains noise free data frames without any complex gains

Conclusion

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LITERATURE SURVEY

Wout Joseph, proposed a calculation for the execution think about on IEEE 802.16-2004 for various conditions like for various channel models and MIMO framework. Chia-Liang Liu clarified the effect of I/Q irregularity on QPSK-OFDM-QAM Detection. The in-stage and the quadrature stage parts are critical segment in QPSK. Yantao Qiao, has made an examination on an iterative calculation of slightest square direct estimation in MIMO OFDM frameworks. The principle target of this paper is an iterative channel estimation calculation for MIMO OFDM is proposed. Sarod Yatawatta proposed an answer for limiting the vitality spent on amid the channel estimation when exposed to known mistake and postpone when timing images are transmitted. The minimization of vitality is conveyed by lessening the equipment, likewise by utilizing a low position leveling at the beneficiary. Benoit Le Saux, proposed a MIMO framework with OFDM has more noteworthy potential like decrease in between image impedance, decline in blurring, increment in transmission capacity, and increment in information rates. The execution of MIMO framework debases because of incorrect channel estimation over recurrence specific quick shifting channels.
Riza Abdolee proposed a strategy to decrease the computational unpredictability of channel estimation calculation for MIMO-OFDM. Channel estimation is high concentrated which experience the ill effects of high computational multifaceted nature. Answer for high effective channel estimation and rearranged computational multifaceted nature is expressed. Deseada Bellido proposed LS channel estimation calculation for MIMO-OFDM. This assessment has been made utilizing pilot configuration decides that ensure a limited blunder level for the estimation. This strategy is utilized for estimation of the channel grid. Markus Myllyla, proposed a strategy for execution assessment of 2 FPGA usage of a LMMSE based finder for radio channels.

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