CHAPTER 2

LITERATURE SURVEY

UWB is a wireless technology that can operate at very low-power density to communicate at high data rates over short distances. OFDM is a multicarrier modulation technique which is capable of achieving high spectral efficiency in multipath fading channels. The OFDM channel estimation symbols are transmitted periodically, in which all sub-carriers can be used as pilots.

Jeffrey Foerster & Andreas Molisch (2003) have developed an wireless channel Model for different channel measurements. These measurements are to establish important differences between UWB channels and narrowband wireless channels, especially with respect to fading statistics and time-of-arrival of multipath components. The different propagation conditions impact system design, like Rake receiver performance. Yang & Ginnakis (2004), described an UWB communication system that can be used as any communication system whose instantaneous spectral occupancy is in excess of 500 MHz or a fractional bandwidth of more than 20%. FCC has not stipulated any specific multiple access and modulation scheme for UWB system. The UWB systems are mainly classified into two categories such as single band and Multiband UWB systems.

Porcino & Hirt (2003) have investigated that the information is transmitted in a single band system by single pulse whereas in Multiband systems information bits are transmitted in many bands. I UWB and DS UWB are the two most popular modulation techniques that are used in single band
UWB systems. The approach employed by UWB radio devices is based on sharing already occupied spectrum resources by means of the overlay principle, rather than looking for still available but possibly unsuitable new bands. Saleh & Valenzuela (1987) have proposed the first channel model for high bandwidth wireless indoor communication. The large bandwidth signals will raise new effects in the receivers as only few multipath components overlap within each resolvable delay bin and amplitude fading statistics are different.

Llano et al (2009) have reported the parameters of UWB channel model based on frequency domain approach with lognormal statistics for MB-OFDM systems. The ultra wideband channel with MB OFDM is analyzed in the frequency domain. The closed analytical expressions for the sub carrier fading statistics in MB OFDM UWB systems was provided. It was reported that the expressions can be used to derive more accurate channel models in both UWB system design and performance optimization.

Sklar (1997) has analyzed the performance of mobile communication channels for fast time-varying and frequency selective fading channels. The major elements that contribute to fading in a communication channel have been characterized. Large scale and small scale fading were described. Two degradation categories like fast and slow fading were defined. A mathematical model using correlation and power density functions was presented. The mitigation techniques for ameliorating the effects of each degradation category were treated and the methods that have been implemented in two mobile communication systems were described. Baddour & Beaulieu (2001), modeled the auto regressive modeling of wireless communication fading channel. The wireless communication channels can be modeled as an auto regressive model since it is time varying.
Sinem Cloeri et al (2003) have surveyed channel estimation techniques for multicarrier communication. The channel estimation methods are mainly classified into three main categories: blind, semi-blind and pilot based. In order to get better throughput efficiency, this thesis proposes RLS, Kalman based blind channel estimation technique for MB OFDM communication. Another subspace based blind channel estimation method by exploiting virtual carriers is proposed (Li & Roy 2003), however this method is not practically feasible. The problem of blind adaptive channel estimation in OFDM systems is considered. Focusing on the zero padding approach, for the first time adaptive algorithms are proposed that blindly identify the impulse response of the multipath channel. In particular, the RLS and Least Mean Square (LMS) schemes exhibit rapid convergence with low computational complexity. Both versions are obtained by properly modifying the orthogonal iteration, a method used in numerical analysis for the computation of singular vectors (Doukopoulos & Moustakides 2004).

Yang et al (2002) have proposed channel estimation for OFDM transmission in multipath fading channels based on parametric channel modeling. This algorithm is based on a parametric channel model where the channel frequency response is estimated using multipath channel model. In this algorithm, the estimation of signal parameters by rotational invariance techniques method to do the initial multipath time delays acquisition and propose an interpath interference cancellation delay locked loop to track the channel multipath time delays. With the multipath time delay information, a MMSE estimator is derived to estimate the channel frequency response. It is demonstrated that the use of the parametric channel model can effectively reduce the signal subspace dimension of the channel correlation matrix for the sparse multipath fading channels and consequently the channel estimation performance is improved.
A pilot based channel estimation technique using Kalman filter for OFDM communication has also been proposed (Cheng & Zhang 2004). In this method, the state transition matrix in the Kalman filter is assumed as an identity matrix. The estimation of state transition matrix of Kalman filter from the received signal vector is given (Enescu & Koivunen 2002). However this method becomes more complex when the prediction order is high.

Mehmet Kemal et al (2007) have represented an extensive overview of channel estimation techniques employed in OFDM systems. In addition, the advantages, drawbacks and relationship of these estimation techniques with each other are analyzed and discussed. The combination of MIMO OFDM systems for higher data rates and estimation techniques are investigated. In their study, methods of various channel estimation algorithms like Linear Minimum Mean Square Error (LMMSE) channel estimation technique has been analyzed in OFDM channel estimation for minimizing the MSE in the presence of AWGN.

Mehbodniya & Aissa (2009) have presented a performance analysis of MB OFDM in the presence binary phase shift keying time hopping technique in Nakagami-m fading channels. In their work, a Gaussian approximation is considered for the UWB interferers and used in the analysis of the BER performance of the MB OFDM systems. The Nakagami-m distribution is applied to characterize the amplitude of the fading channels for both reference and the interference signals. A waveforming technique has been considered for mitigating the effect of interference and its efficiency in terms of BER improvement.

Zhiwei Lin et al (2012) have investigated an iterative Sample Frequency Offset (SFO) estimation method for a high-data-rate MB OFDM UWB system to improve its SFO estimation accuracy in the case of a long transmission packet. The proposed method is an iterative process of 2-D SFO
estimation across pilot subcarriers and consecutive OFDM symbols, together with joint channel estimation. Leïla Najjar (2012), structured the LS channel estimation MSE performance, conditioned to a detected CIR structure has been studied. The obtained MSE allowed for deriving the SNR limit below which the structured estimate based on the true CIR structure is no longer optimal in the MSE sense. Furthermore, approximations of the SNR threshold more suitable to predict in practice, are proposed. The performance study has been performed for both block and comb-type channel estimations. In addition, an extension to the case of spectral shaped systems with guard bands insertion is elaborated.

Melisa Barrera et al (2009) have used a SNR algorithm based on the moments of the received signal has been proposed. This algorithm has been designed for MB OFDM communication systems in UWB channels. Here a switched estimator was designed that uses two models, one is for large SNR scale and other for low SNR scale. This model can be used for SNR estimation in adaptive modulation, channel estimation and link quality control in MB OFDM system and it can be implemented in receivers with simple structures.

Zhongjun Wang et al (2010) have proposed an efficient channel estimated scheme for MB OFDM based UWB communication systems and more specifically for practical implementation of low cost, high speed, UWB based wireless USB devices. The proposed method consists of two stages. The first stage employs a simple least square method together with a frequency domain smoothing operation that estimate the channel using the available training sequence. The second stage uses this channel estimate to detect the frame header and then refines the channel estimate by using decision directed technique. The MSE performance and computational complexity is analyzed.
Nicolò Michelusi et al (2012) have investigated the problem of channel estimation in UWB systems. Due to the large transmission bandwidth, the channel has been traditionally modeled as sparse. A novel Hybrid Sparse Diffuse (HSD) channel model is proposed. Tailored to the HSD model, channel estimators are designed for different scenarios that vary in the amount of side information available at the receiver. An Expectation-Maximization algorithm to estimate the power delay profile of the diffuse component is also designed. These methods are compared to unstructured and purely sparse estimators. The new channel estimators are evaluated with more realistic geometry based channel emulators. The numerical results show that, even when the channel is generated in this manner, the new estimation strategies achieve high performance. Moreover, a MSE analysis of the proposed estimators is performed, in the high and low Signal to Noise Ratio regimes, thus quantifying, in closed form, the achievable performance gains.

Sinem Coleri et al (2002), investigated a study of channel estimation in OFDM system. The channel estimation techniques for OFDM systems based on pilot arrangement were investigated. The channel estimation based on comb type pilot arrangement was studied through different algorithms for both estimating channel at pilot frequencies and interpolating the channel at pilot frequencies and interpolating the channel. The estimation of channel at pilot frequencies is based on LS and LMS while the channel interpolation is done using linear interpolation, second order interpolation, low pass interpolation, spline cubic interpolation and time domain interpolation. The channel estimation based on block type pilot arrangement was performed by sending pilots at every sub-channel and using the estimation for specific number of symbols.

Nian Geng (2012) has proposed a low-complexity Dual-Diagonal (DD)-LMMSE channel estimation algorithm for OFDM systems involving
iterative channel estimation and signal detection. Computational complexity and MSE analysis are presented to evaluate the efficiency of the proposed algorithm. A closed-form expression is derived for the asymptotic MSE of the DD-LMMSE channel estimator. Both analysis and numerical results show that DD-LMMSE performs close to the well-known LMMSE estimator with much lower complexity.

Yun Liu et al (2009) have developed an blind estimation of subcarrier number in multiband Ultra wideband communication system. In this method, a new approach of blind estimation of subcarrier number based on multiple signal classification algorithm has been developed for UWB systems. Ch. Sasmita Das et al (2010), evaluated on the performance of MB OFDM is attempted for high data rate UWB for WPAN physical layer standard according to modulation techniques such as QPSK, 16 QAM, 64-QAM for different multipath components. The UWB channels are characterized by different delays and attenuation for different amplitude fading statistics for UWB channel.

Zhong Wang et al (2010) have proposed an efficient channel estimation scheme for MB-OFDM based communication systems and more specifically for practical implementation of high speed, UWB based wireless USB devices. Wen Zhou and Wong-Hing Lam (2010), developed an algorithm for channel estimation and data detection for OFDM systems over fast fading and dispersive channels. Channel estimation and data detection method for OFDM systems over the fast fading dispersive channels has been proposed and investigated. A new pilot pattern has been proposed and it consists of two classical pilot patterns, which are the comb type pilot pattern and grouped pilot pattern. The required number of pilot subcarriers is significantly reduced compared with that of using the grouped pilot patterns.
only. It is more suitable for to mitigate ICI and to improve the performance of OFDM system.

Tanee Demeechai et al (2012) have considered a frequency-domain algorithm for OFDM-timing estimation. The OFDM system is to operate in a known narrowband interference channel. The performance of the proposed frequency-domain algorithm has been analyzed for OFDM timing estimation. The algorithm is based on a complex timing metric that has the mean of which the angle depends in an affine manner on the time offset. Computing the mean of the metric and the mean square of the metric component orthogonal to the mean from the power-delay profile and noise condition of the channel, the channel-induced bias of the estimator is quantified and the root-mean-square of the estimation error is estimated.

Riazul Islam & Kyung Sup Kwak (2010) have developed Wiener-Hopf interpolation aided Kalman filter based channel estimation algorithm for MB OFDM system in time varying dispersive fading channel. Two stage approach has been used to develop this algorithm. In the first stage, Winner-Hopf filtration has been employed for the interpolation of unknown channel state information using comb-type known pilots. In the second stage, interpolated channel statistics are then modeled as autoregressive process and fed in to Kalman filter. In order to suppress ICI, the mitigation filters jointly work with Kalman filter.

Stefano Rosati et al (2012) have addressed the OFDM data-aided channel estimation based on the decimation of the CIR through the selection of the Most Significant Sample (MSS). The aim of approach the MMSE channel estimation performance, while avoiding the need for a priori knowledge of channel statistics. The optimal set of samples is defined in the instantaneous and average senses.
Hussein Hijazi & Laurent Ros (2010), developed a joint data detection and Kalman estimation algorithm for OFDM time varying Rayleigh channel with complex gains. In their work, the knowledge of delay related information is considered an iterative algorithm for joint multipath Rayleigh channel complex gains estimation and data recovery in fast fading environments has been proposed. The Jakes process, Auto Regressive (AR) model of the polynomial coefficients is built, making it possible to employ the Kalman filter estimator for the polynomial coeffecients.

Seung Hyun Nam et al (2010) have proposed a Quasi Newton based Kalman filter channel estimation for OFDM systems. The Kalman filter method has been used for the estimate of time variant channels in OFDM systems. The estimation is based on comb type pilot in frequency domain. The channel coefficients that belong to the pilot subcarriers are estimated by Kalman filter. To reduce complexity, quasi newton methods are adapted for updating the gain of Kalman filter.

Neetu Sood et al (2011) have evaluated the performance of OFDM system based on BPSK and QPSK modulation techniques with and without channel estimation over Nakagami-m fading channels. The threshold value played a significant role in channel estimation as the minimum value of BER. Mohammed Safiqul Islam et.al (2011), analyzed the performance of different modulation schemes using OFDM techniques in Rayleigh fading channel. It deals with the communication system that uses M-ary PSK and M-ary QAM to transmit information using OFDM technique over Rayleigh communication channel. In terms of Symbol Error Rate (SER), the performance of different modulation schemes using OFDM techniques in Rayleigh channel is analyzed. Aawatif Menouni Hayar & Giorgio Vitetta (2009) have presented an overview of UWB channel modeling. The state of the art on UWB channel models based on both empirical and statistical approaches are illustrated.
Mingchao Yu & Parastoo Sadeghi (2012) have studied a comparative analysis of channel estimation methods for pilot-assisted OFDM communication systems in time-varying frequency-selective fading channels. An improved low-complexity LS estimation method based on the domain-transform process, which estimates time-domain CIR using the LS estimate of pilot subchannels was also proposed. This method is particularly suited for commercial OFDM systems such as Digital Terrestrial Television Broadcasting Systems (DVB-T2) properties. This method provides competitive Bit Error Rate (BER) and channel estimation error performance, compared with some well-known methods which suffer from either a much higher computational load or less robustness to Doppler shifts or timing errors. For irregular pilot patterns, efficient yet simple regularization methods are suggested to solve the ill-conditioned problem of the estimation matrix. An upper bound on the MSE of the estimated CIR is also provided.

Saqib Saleem & Qamar-Ul-Islam (2011) have analyzed the performance and complexity comparison of channel estimation algorithms for OFDM systems. Two basic algorithms have been considered for channel estimation using pilot based channel estimation technique. First one is Least Square Estimation (LSE) and the other one is LMMSE. LSE has less complexity and it minimize the MSE of the channel by utilizing the information operating SNR and the channel statistics due to which its complexity is higher. To overcome this problem LMMSE channel estimation technique has been proposed to reduce the complexity by the use of channel taps and CIR samples.

Seyed Alireza Banani & Rodney Vaughan (2010) have presented blind channel estimation technique for uncoded OFDM systems. The optimal MMSE channel estimation has been proposed. This technique requires only one value from the time–frequency correlation of the channel transfer
function and comparison made between with known decision-directed Kalman-based estimation and two pilot-aided OFDM schemes such as block pilots and comb pilots based estimation.

Ping Wan et al (2011) have proposed a low-complexity iterative receiver combining joint iterative Channel Estimation (CE) with symbol detection coded OFDM systems in fast-fading channels with Doppler frequencies up to 15% of the OFDM subcarrier spacing. The receiver exchanges information between the channel estimator and detector in an iterative fashion to obtain accurate estimates of the Channel State Information (CSI). The channel is modeled as a weighted sum of fixed Basis Expansion Model (BEM) functions. The BEM coefficients are characterized as a multivariate AR processes and estimated with a Kalman filter. The initial channel estimate is performed from sparse pilot signals. The informations are detected and decoded and the channel is estimated again based on the estimated transmitted data. The cycle of detection, decoding and CE is repeated until convergence.