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Performance Analysis of TFT-OFDM Systems in Long Delay Channels Using Turbo Codes

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ABSTRACT:In this paper a very efficient compressive sensing technique is applied in a time frequency training multiplexing (TFT-OFDM).From the channel information received from TFT OFDM we apply it to the auxillary subspace pursuit (A-SP) algorithm.This algorithm has lesser complexity and makes use of the PN coarse path delay estimation.The path delay estimation is done by making use of the most significant taps.We make use of the pilot carriers which should be sparse.The sparse signals are generated by using the theory of Compressive Sensing(CS).The performance evaluation was done for both low density parity check (LDPC) code and turbo codes with puncturing.It was seen that the turbo coded TFT OFDM showed better performance especially when the channel length is close to or even greater than the guard interval length for 256 quadrature amplitude modulation(QAM) in different channels**.**

KEYWORDS: Compressive Sensing,Auxillary Subspace Pursuit algorithm,path delays,Turbo codes.

I.INTRODUCTION

In the previous year's OFDM is being widely implemented in various wireless devices.Among the different multiplexing technique TFT –OFDM has gained wide acceptance because of its feature of making use of both the time and frequency.It has proved to be more progressive than the time domain synchronous (TDS) OFDM as the TDS OFDM can't mitigate the interblock interference (IBI). The pseudo noise OFDM (DPN-OFDM) was used to overcome this disadvantage.But it had lesser spectral efficiency.The TFT-OFDM makes use of higher modulation schemes such as 256QAM and thus finds application in ultra high definition television(UHDTV).In long delay channels all the signals that are arriving from different direction need not be of maximum importance.Therefore the method of finding the most significant taps is used in which the signals found are the base.These signals are sparse in nature. The algorithm has two important characteristics: low computational complexity, comparable tothat of orthogonal matching pursuit techniques and has priori knowledge as aswell when appliedto very sparse signals, and accuracy with lesser complexity.

II. LITERATURE SURVEY

In this paper we highlight the fundamental concepts of compressive sensing and give an overview of its application to pilot aided channel estimation. We point out that a popular assumption – that multipath channels are sparse in their equivalent baseband representation – has pitfalls.There are overcomplete dictionaries that lead to much sparser channel representations and better estimation performance.An in-depth study of the second-order statistics of the signal received through a noise-free sparse OFDM channel reveals the sparsity and other properties of the correlation functions of the received signal. These properties lead to a direct relationship between the positions of the MSTs of the sparse channel and the most significant lags of the correlation functions, which is then used in conjunction with a pilot-assisted LS estimation to detect the MSTs in a semi-blind fashion. It is also shown that the new MST detection algorithm can be extended for the estimation of multiple-input–multiple-output.Turbo codes are the channel coding scheme used in wireless cellular networks as they are able to reach close to the Shannon limit. This paper proposes the use of turbo codes for storage of data. Turboencoding can be performed by using parallel Recursive Systematic Convolutional (RSC) encoder and aninterleaver while turbo decoding is based on the MaximumAposterior Algorithm (MAP).Selection criteria for the puncturing vector to achieve excellent performancein terms of BER and gives useful guideline for design of puncturing vector based on simulation result.

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III.COMPRESSIVE SENSING

A signal that has its most weighting coefficients in the transform domain as zero can be represented or created by using lesser number of samples than usually required in a sampling process.It is basically dependent on the sampling matrix and the sampling rate.In compressive sensing the sampling rate is less than $2f_b$ which means that it takes lesser sampling rate than nyquist rate.Compressive Sensing has wide applications in the field of medical apllications like ECG,MRI and pixel cameras.Itis used to know the individual arrivals in a multipath arrival environment.In the previous studies priori aided compressive sampling matching pursuit (PA-CoSaMP) algorithm was used.In this we paper we propose the auxillary subspace pursuit with lesser complexity.With this algorithm we do the CS based channel estimation(CE). .There are two properties:

1)incoherence

2)sparse nature

The incoherence is of two types that is the lower coherence and higher coherence.Lowerincoherence means more difference and compressive sensing provides that.Thus the signals can be recovered with high probability.To implement this compressive sensing process in an OFDM we need to consider the following points:i)A channel model should be considered to estimate the sparse signalsii)We need to place the pilots in such a way that the interference from other pilots have to be observed and from other data symbols has to be also considered as noise.

IV.TURBO CODED TFT OFDM SYSTEM

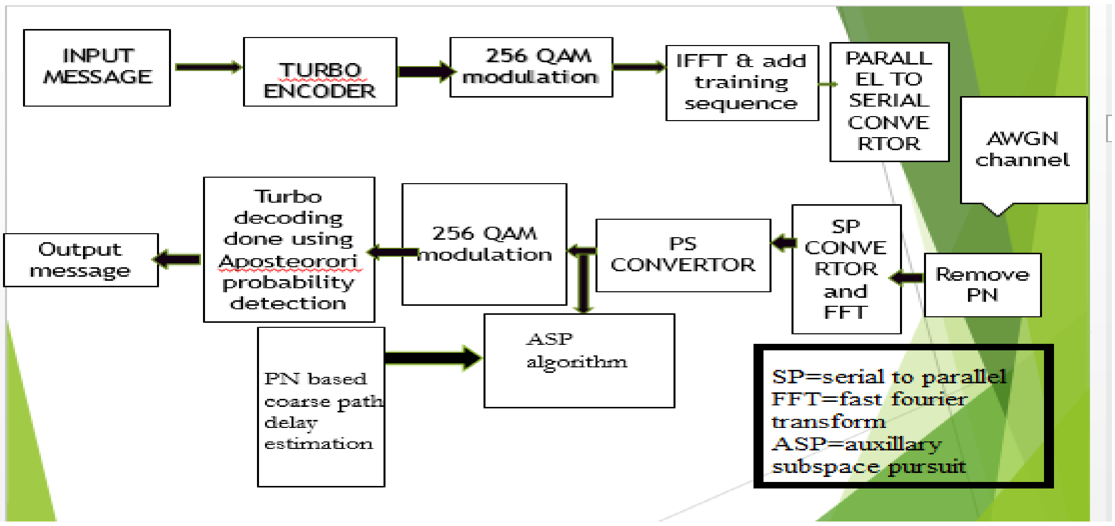

Fig 1. TFT OFDM system model using turbo codes

There are two recursive systematic convolutional encoders. The first encoder received the data stream from the random generator, while an interleaved version is received by the other encoder. The interleaver used is a random interleaver.It is used so the interleaved output maybe different from the other output to avoid the occurance of low weights in all the output. The inter-lacers distribute the incoming information in both out- puts. It is done to provide a systematic and a recursive version of the input. In the typical parallel system two interlacers provided three outputs in which the first output is systematic while the other two are the recursive versions or the parity bits.An additional puncture block produced another recursive signal. Puncturing is done to acquire better performance in BER rate.We increase the data rate by using puncturing.It systematically adjusts the code rate with the system performance.There are different types of puncturing and is used in applications like satellite communication.Then transmission done using OFDM as shown in fig1.

Turbo decoding technique is done in many iterations and contains A Poste- riori Probability (APP) .The likelihoods received are iteratively decoded.Theinterleaver used in the decoding is same as that of encoding. The decoding is done by using Maximum Aposteriori with log likelihood ratio.The decoding is done iteratively.At each round the decoders function is to revaluate their estimates using information from the other decoder.The out- put of the inner is given to the outer decoder. In turn, the outer decoder's outputs are given as feedback section.When using turbo

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codes BICM techniques it is seen that the it finds much application in digital broadcasting.It also can double the capacity.It can be used in a multipath environment such as SFN and will use less guard interval time.

Turbo codes are those codes that are able to reach close to the Shannon limit. Low Density Parity-Check (LDPC) codes have a generator matrix of the code word to be identified. In LDPC decoding we use the belief propagation algorithm. Finally, a comparative analysis on turbo and LDPC codes is done. Experimental results show turbo codes perform better than LDPC codes.The most popular algorithms for the path delay estimation are the greedy algorithms, like Matching Pursuit (MP) orOrthogonal Matching Pursuit (OMP), that identify the nonzero elements of x in an iterative fashion.The nonzero element set is first set to zero.The observations are set as the residual, r = z.Correlate all columns of A with the residual andchoose the largest element by magnitude and add it to the set of non-zero elements. We apply the condition that only elements of x are nonzero that have been added , this helps in finding an estimate that can minimize.Thus we can update the new residueˆ. Repeat steps until we get below a predetermined threshold.This type of algorithm has been popular mainly because it can be easily implemented and has low computational complexity. This has lead to renewed interest in dynamic, leading to new greedy pursuit algorithms like the priori aided compressive sensing sampling matching pursuit(PA-CoSaMP) algorithm.The input that is given are:

1) Initial path delay set D_0, channel sparsity level S, initial channel sparsity level S_0;

2) Noisy measurements y, observation matrix Φ.The output that we get is Ssparse estimate $\hat{h}$of the channel impulse response(CIR).

V.AUXILLARY SUBSPACE PURSUIT ALGORITHM(ASP)

Basically there are three steps:
1) Coarse path delay estimation done using PN sequence.This can be done by the parity aided compressive sampling pursuit (PA-CoSaMP) algorithm. From this we get the path delay estimation.We do not consider the path gains.The path delays of the most significant taps are calculated.This is given as the auxillary information for the Auxillary Subspace Pursuit(ASP).The auxillary information is taken for the initial configuration of the ASP algorithm.The coarse channel estimate is found.We find the channel sparsity level S.Thus this will contain only the initial path delay
2)In the second step we have to reconstruct the OFDM block.This is done using the overlap add (OLA) algorithm.This helps in removing the IBI caused by the PN sequence.After using the OLA algorithm we also get the useless part that is formed by the linear convolution of PN sequence and OFDM block.This has to be removed so as to get cyclicity .
3)In the third step we make use of the ASP algorithm the exact channel impulse response (CIR) .The auxillary information received will reduce the complexity of the ASP algorithm.Herewe have the initial value from the path delay and therefore it helps in providing initial configuration.In ASP we subtract after each iteration, the remaining most significant values are taken.The main three steps in ASP algorithm are:
1)Initial Configuration
2)Significant Entry Identification.
3)No of iteration

VI. TFT OFDM SYSTEM

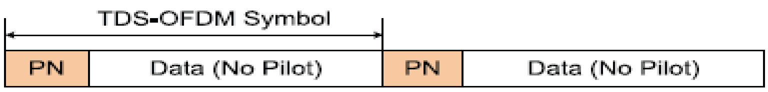

Fig 2. TDS-OFDM system

There are three types of OFDM-based blocktransmission like cyclic prefix OFDM (CP-OFDM), zero padding OFDM (ZP-OFDM), and time domain synchronous OFDM (TDS-OFDM). TDS-OFDM has the pseudorandom noise (PN) sequence, as the guard interval as and the training sequence (TS).The DPN-OFDM scheme usesthe second received PN sequence immune from IBI for CE.Thus, the iterative IBI removal can be avoided, but significantloss in spectral efficiency will be introduced .As shown in Fig. 2 presents the system model of time domain synchronous (TDS) . Unlike the conventional TDS-OFDM or CP-OFDM wherethe training information only exists in either the time or frequencydomain .

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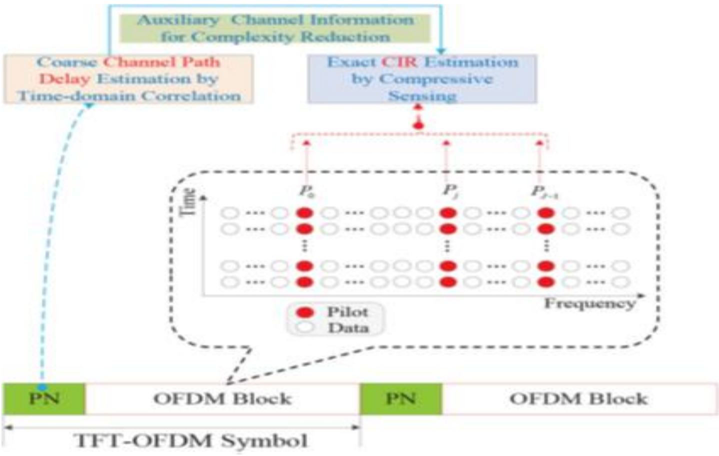

Fig 3.TFT-OFDM System model

Fig. 3 shows that TFT-OFDM hastraining information in both the time and frequency domainsfor every signal symbol, i.e., the time-domain TS and thefrequency-domain pilots scattered over the signal bandwidthare jointly used in TFT-OFDM. The *i*th TFT-OFDM signalsymbol $\boldsymbol{s^i} = \left[\boldsymbol{s_0^i}, \boldsymbol{s_1^i}, \ldots, \boldsymbol{s_{M+N-1}^i}\right]^{\boldsymbol{T}}$is composed of theknown PN sequence $\boldsymbol{c}$ = ***c0,c1,….,cM−1*** *T*of length *M* and the OFDM block = ***xi=x0i,x1i,….,xN−1iT***of length *N*,

i.e$\boldsymbol{s^i} = \begin{bmatrix} c \\ \boldsymbol{x^i} \end{bmatrix}$

In contrast to the conventional TDSOFDM, the OFDM block in TFT-OFDM contains not only the traffic data, but also a small number *J* of pilots.ɼ is the pilot location set and represented asɼ= $\{P_0 P_1, \ldots, P_{j-1}\}$where 0 ⩽*P*0 < *P*1 < · · < *PJ*−1 ⩽*N* − 1 . By the use of CS the pilot number *J* could be reduced significantly and hence the spectral efficiency loss is negligible. The difference is that the pilots are equally spaced in exixting schemes, while the pilots are randomly located in the proposed scheme to ensure good CE performance based on CS.

So far it was assumed that y is available, and that one can simply apply the transform into the domain of $\{\{\psi_{k=1}^{n}\}$ to determine which x_k are relevant (non-zero). Although thiscase does exist and is important for some forms of data compression, the real application of compressive sensing is theacquisition of the signal from m, possibly noisy, measurementsz = $\boldsymbol{\Phi^H}_l$y + v_l for l= 1, . . . ,m, where here it is assumed that v_l is zero-mean complex Gaussian distributed with variance N0 and the noiseless case is included for N0 → 0. The signal acquisition process can now be written using the m×n matrixA,

z = $\boldsymbol{\Phi^H}$y + v = $\boldsymbol{\Phi^H}\psi x + v$.

where$\boldsymbol{\Phi}$ = $[\boldsymbol{\Phi}_1, \boldsymbol{\Phi}_1, \ldots \ldots, \boldsymbol{\Phi}_m]$ is an n × m matrix and z =$[z_1, z_2, \ldots, z_M]^T$ is the stacked measurement vector.Sincethis is a simple linear Gaussian model, it is “well posed” aslong as A is at least of rank n. By “well posed” we simplymean that there exists some estimator ˆx (or ˆy for that matter),whose estimation error is proportional to the noise variance;therefore as the noise variance approaches zero, the estimationerror does as well.If the channel is exactly known at the receiver, the IBI of thePN sequence on the OFDM block can be completely removed.Then, by using the idea of the classical overlap and add (OLA)algorithm , the cyclicity reconstruction of the OFDM block can be obtained and hence the CP effect can be restored.In the proposed scheme, the time-domain PN sequence and the frequency-domain pilots are jointly exploited to perform the CE.

VII. RESULT AND DISCUSSION

This section shows the performance evaluation of TFT-OFDM systems using LDPC codes and Turbo codes under two different channel models.The performance evaluation is done for BER and MSE rate.It is seen that when channel length is greater than guard interval length that we see that the TFT-OFDM has better performance than TDS-OFDM.The turbo code is given at a rate of 1/3.The message length is 4096and the training sequence is 64 in length.256QAM is the modulation scheme used.We have done this analysis for channel length greater than the GI(guard interval) length in an extremely long interval delay .

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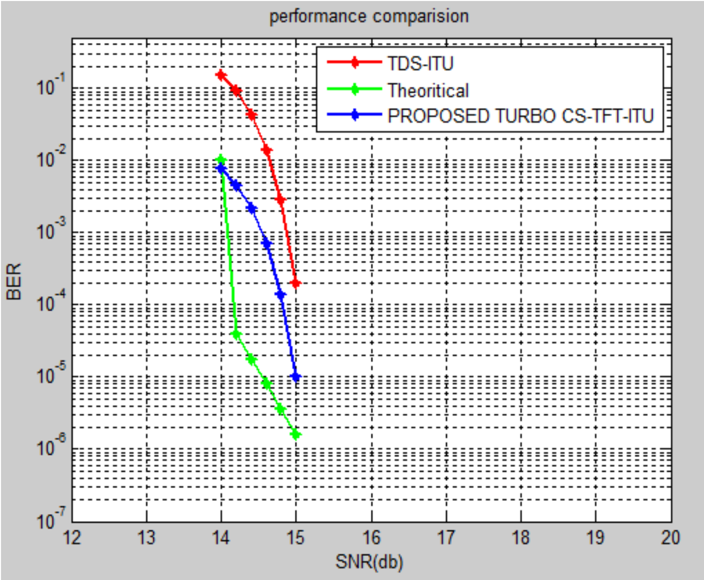

Fig. 4 BER vs SNR of TFT-OFDM using turbo codes in SARFT channel

In the fig4, it shows the graph of BER vs SNR rate in different channel for the TDS-OFDM system and the proposed system.It is seen that the proposed system enjoys a performance of 10^{-1} than that of the proposed system.Thus better performance with lesser complexity.This is evaluated in a SARFT channel which supports the wireless standards.

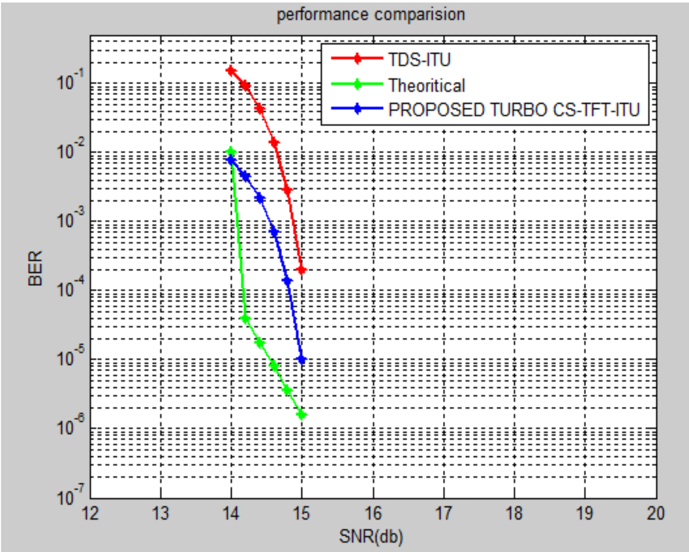

Fig. 5 BERvs SNR of TFT-OFDM using turbo codes in ITU-VB channel

In fig5 the BER is evaluated in ITU-VB channel model for static environment.Itis evaluated on the condition that the guard interval is greater than the channel length.This is for the extreme case.It is seen that the proposed TFT-OFDM system has a BER rate close to the theoretical value. The vehicular channel models are there for different power levels.

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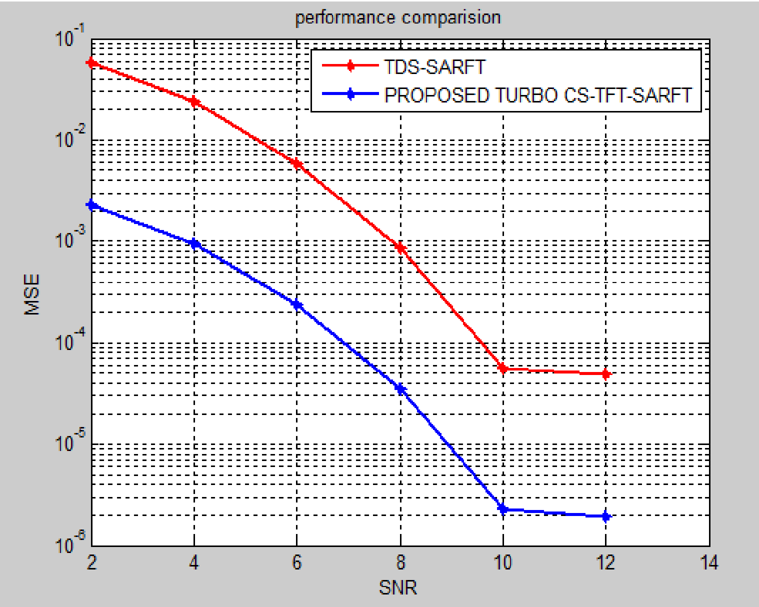

Fig.6MSE vs SNR of TFT-OFDM using turbo codes in SARFT channel

The difference occurring because of randomness or because the estimation doesn't account for a value that could produce a accurate estimate is called mean square error (MSE).In fig6 the mean square error value is almost close to the theoretical value.Thus spectral efficiency is increased.It can be seen that under the State Administration of Radio, Film & Television (SARFT) channelwhich is responsible for controlling the access to satellite and cable networks as well as supervising their operations, the MSE performance of the proposed scheme enjoys a significant SNR gain

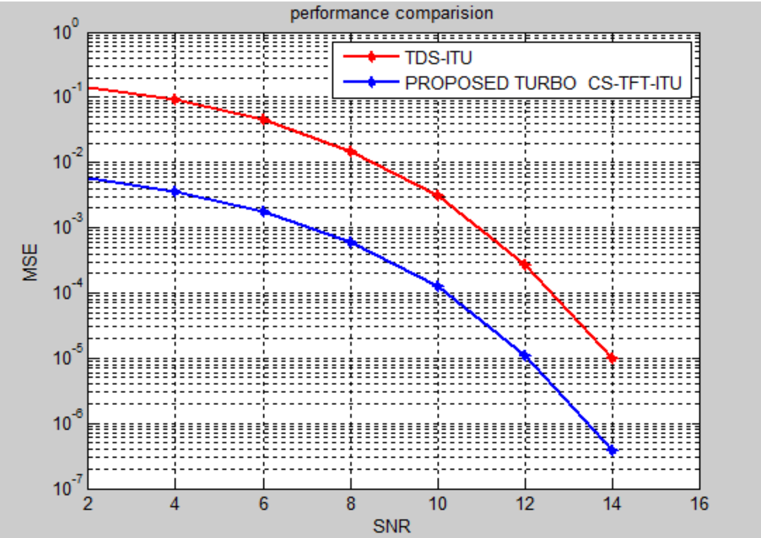

Fig .7 MSEvs SNR of TFT-OFDM using turbo codes in ITU-VB channel

It is seen that the proposed system has a MSE performance of more than 10^{-1} in both the channels .The channel tabs used are 8.The MSE performance of the proposed scheme has better signal to noise ratiogain (SNR)of 6db which is measured in db.The ITU-Vehicular B has rake finger of 7.The rake finger helps against interferences.

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VIII.CONCLUSION

Compressive sensing has made a great impression in the signal processing and broadcasting community, where besides an intriguing theory it offers versatile applicability to many challenging problems. In the communications community the application of compressive sensing has been mainly on sparse channel estimation with MST's, with extensions to multiuser and cognitive radio systems. In this paper, we illustrated the application of the compressive sensing techniques in long delays by using the joint estimation. Every TFT-OFDM symbol has time-frequencytraining information composed of the timedomain TS and a very small number of frequency-domain grouped pilots. With the joint timefrequency channel estimation, the received TSis directly utilized to merely acquire the path delay information of the channel, while the path coefficientsare estimated by the frequency-domain pilots.The present system has lesser complexity and since we use turbo codes with puncturing ,it uses lesser system memory.It also helps in retrieval of data in large clusters.The interleaving done will also help in increasing code rate.

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