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An Effective Method of Decoding Layered Signal in OFDM Using Particle Filter

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Abstract

In general hierarchical demodulation technique undergo serious interlayer interference (ILI) due to multiple layer of modulation present in Hierarchical broadcasting, this will degrade the performance of basic layer signal in the reception. The proposed method include structure based LDPC decoding algorithm for Hierarchical modulation, this algorithm introduces structure information on the secondary layer thus offering performance gain in reception. Under various channel condition this algorithm can be applied to different mapping scheme and channel coding and also implemented on a broad-band in-band-on-channel digital radio broadcasting system. LDPC is implemented based on particle filtering in order to predict the noise variance accurately and to reduce the BER.

Keywords: Hierarchical modulation (HM), Low density parity check codes (LDPC), Particle filtering algorithm.

Introduction

In general mobile wireless links are varying over time in nature thus the transmitter find different users with different link qualities to transmit message of same quality for the time varying nature of fading, adaptive transmission technique have been introduced .This technique change transmission and reception parameters mostly this technique undergo uniform signal constellation whereas Hierarchical constellation are non uniformly spaced signal points thus offering protection at different level to the transmitted message symbol based on their priorities. Hierarchical modulations are widely recognized against bad wireless environments to protect highly sensitive information .

It can transmit two datas with various priority levels over a single frequency or multiple frequency channel.

The high and low priority data are mapped to the most and the least significant bits of modulation constellation points, which is called the base layer data and the enhancement layer data.In order to cover the cell area and to balance data rate, hierarchical modulation technique have been implemented this modulation technique compromise both the coverage area and data rate .Unlike the single-layer broadcasting, the HM broadcasting provides multiple layers of data streams, each layer has a different carrier to noise (C/N) threshold and a corresponding coverage area, all the layer have same transmission bandwidth. In this paper we use layered modulation (HM) which consists of basic layer signal and secondary layer signal, basic layer carries essential data information of either audio or video signal whereas secondary layer carries the enhancement information to increase the quality of that signal in fig (2) the base station transmitting both layer signal the terminal that is near to the base station can able to demodulate both layer signal this is because of low C/N ratio but the terminal that is far away from the base station only demodulate the basic layer signal due to large C/N ratio.

Due to addition of layers effective transmission power get reduced but there is some drawback in retrieving the basic layer it will undergo high performance loss. The prime cause of loss is inter layer interference (ILI).The ILI reduction can be carried in either transmitter or receiver side, the performance gain offered by both transmitter and receiver approaches become limited when the HM signals are channel coded (e.g., low-density parity-check code (LDPC) or turbo codes).

In the receiver model ILI problem will be overcome by implementing particle filtering algorithm in LDPC decoding

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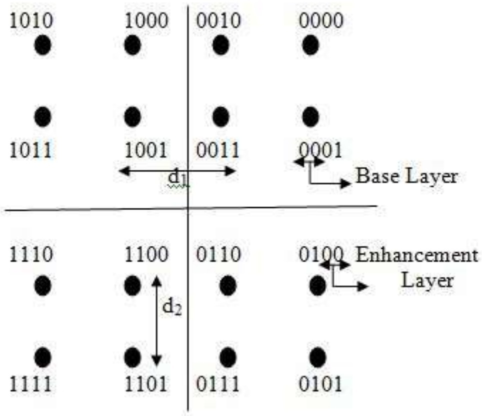
Hierarchical modulation

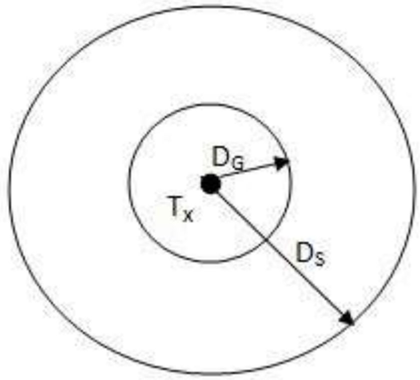
Hierarchical modulation is a type of digital modulation where we superimpose multilayer signal with using same or different modulation technique and transmitting as a one symbol stream. In a one transmitter Hierarchical modulation allows 2 digital data streams such as low priority bit stream and high priority bit stream. low priority data having higher bit rate and sensitive that is higher C/N needed whereas high priority data having low bit rate and lower C/N is needed which is robust. When hierarchical modulation is employed good users or nearby users can demodulate both the layer signal.

The traditional hierarchical modulation suffers from inter-layer interference (ILI) so that the achievable rates by low-layer data streams, e.g. the base-layer data stream, can be dented by the interference from high-layer signals. HM provide different receivers according to their channel states, which is an effective method to improve the transmission efficiency without adding any redundancy to the modulated data Fig 1 shows the constellation diagram of a 4/16-QAM modulation scheme, where d1 represents the distance between two fictitious symbol while d2 represents the distance between two neighboring symbols within one quadrant Hierarchical modulated symbol consists of 4 bits. The base layer information is formed by the two most significant bits .It ensures receivers meet the basic audio or video signal in high speed mobile environments or poor channel condition. The enhancement layer information is mapped onto the two least significant bits. It provides high quality for users with good channel states. The qualities of received signal related to transmission power ratio of the base layer and enhancement layer



Fig(1): Hierarchical constellation points

Here take a view of a circular symmetric cell with Transmitter as a center and *d* is the distance between the transmitter and the receivers. These receivers cell are classified into two groups. One group consists of receivers located nearer to the transmitter($d < D_G$)component. This class is characterized by a Rayleigh fading channel with a high receive SNR. The other group has no direct path component, and it is at a greater distance ($D_G < d < D_S$) from the Tx. This class is, therefore, characterized by a Racien fading channel with a moderate receive SNR.



Fig(2): Symmetric cell models to illustrate nearer and farthest receivers

In digital TV broadcasting there are two different groups of receivers are described above naturally leads to a hierarchical transmission scheme. Therefore, the first requirement is a hierarchical source encoder/decoder which splits the digital TV data into two parts of different significance, called high priority (HP) signal and low priority (LP) signal, also known as basic signal and incremental signal respectively.

The two transmission signals vary in their susceptibility to noise. The basic signal is more robust in other words, heavily protected against noise and interference, but cannot support a high data rate, whereas the incremental signal is capable of handling a higher data rate with a compromise of much less robustness. As a result, the coverage of the service area differs in size. The basic signal can be used to supply a larger coverage area compared with non-hierarchical modulation, while the coverage area of the incremental signal is slightly smaller, or roughly as large as in the non-hierarchical case

Particle filtering

Particle filters method is a type of on-line posterior density estimation algorithms that estimate the posterior density of the state-space by directly implementing the Bayesian recursion equations. The particle filter uses a grid-based approach, and it uses

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a set of particles to represent the posterior density. This kind of filtering methods makes no restrictive assumption about the dynamics of the state-space or the density function. Particle filter provide a methodology for generating samples from the required distribution without requiring assumptions about the state-space model or the state distributions. When applied to high-dimensional systems, this method does not work well. In a real time Particle filters are used to analyzing dynamic problems.

By using an ensemble based approach we can implement the particle filter in the Bayesian recursion equations. The samples from the distribution are represented by a set of particles each particle have its own weight and it represents the probability of such particle to be sampled from the probability density function. Weight disparity leading to weight collapse is a common issue encountered in these filtering algorithms however it can be overcome in conjunction with a resampling step before the weights become too uneven. In the resampling step, the particles with low weights are replaced by new particles in the concurrence of the particles with higher weights.

The main objective of a particle filter is to estimate the posterior density of the state variables given the noticeable variables. The particle filter is also construct for a hidden Markov Model, where the system consists of hidden and noticeable variables. Correspondingly the dynamical system describing the change of the state variables is also known probabilistically. A generic particle filter estimates the posterior distribution of the hidden states using the observation measurement process. Consider a state-space shown in the diagram

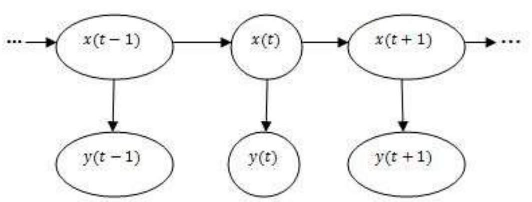
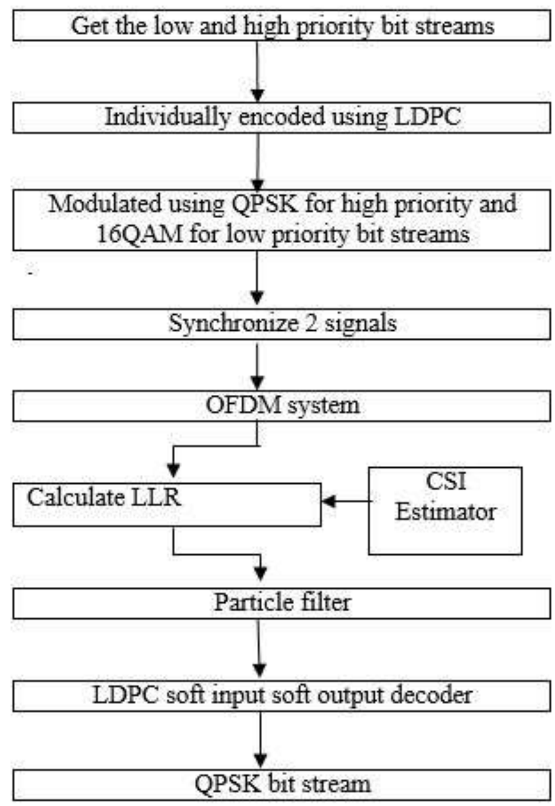


Fig (3): The State-Space (x defines Hidden states, and y defines noticeable states)

A **particle** consists of an practice of a value to a set of variables and its associated weight. For analyzing dynamic problems in real-time particle filters were developed. In **particle filtering** algorithm before moving to the next variable it generates all the samples for each variable. It does extend through the variables, and for each variable it does a extend through all the samples. It also includes a new operation of resampling. This algorithm has an advantage when the variables are developed actively and there can be unlock many variables. Talking a set of samples on some variables, **resampling** consists of taking N samples, each with their own weights, and generating a new set of n samples, each with the same weight.. Resampling can be implemented in the same way that random samples for a single random variable are generated, but samples, rather than values, are selected. Some of the samples are selected multiple times and some are not selected.

System model

High priority bit streams and low priority bit streams are individually encoded using LDPC encoder followed by different modulation technique such as (QPSK,16QAM and so on) here we take QPSK for high priority and 16QAM for low priority bits whereas in the receiver side HM signal were passed through detector where LLR value is calculated with two inputs, modulation scheme of secondary layer and CSI estimator followed by particle filtering then LDPC detector detects the basic layer bit stream for farthest user



Fig(4):Flow diagram of proposed system

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Algorithm

1.Initially, set time t =0

- for j=1,..., N: sample $y_0^{(j)} \sim p(y_0)$; t:=1;

2**. Importance Sampling**

- for j=1,..., N: sample $y_t^{(j)} \sim p(y_t|y_{t-1}^{(j)})$

$y_{0:t}^{(j)} := (y_{0:t-1}^{(j)}, y_t^{(ij)})$

- for j=1,..., N: evaluate importance weights $w_t^{(j)}=p(z_t|y_t^{(j)})$

Normalize the importance weights

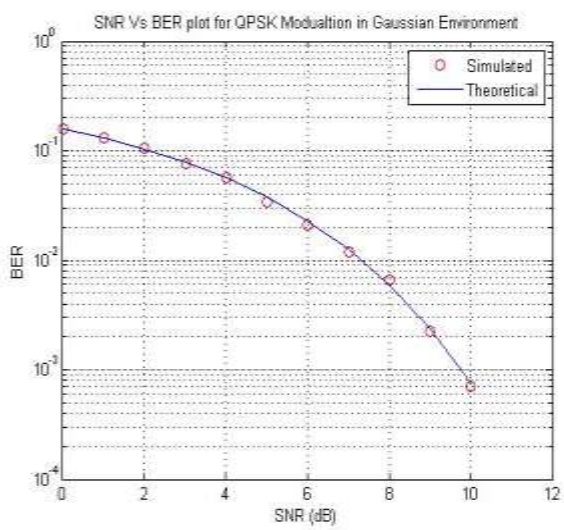
3. **Selection / Resampling**

- resampling with replacing N particles $y_{0:t}^{(j)}$ based on importance weights

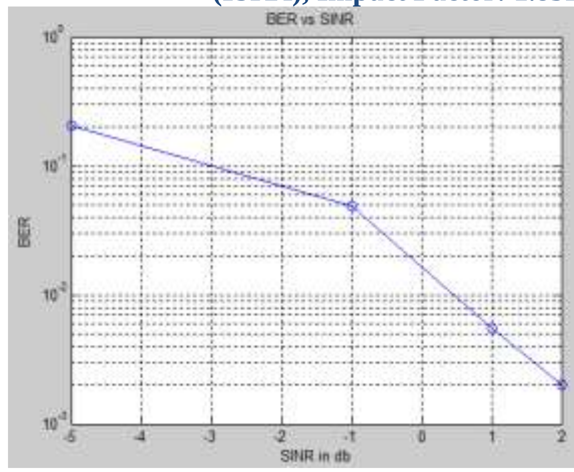
Set t=t+1 and go to the step 2

Results and discussion

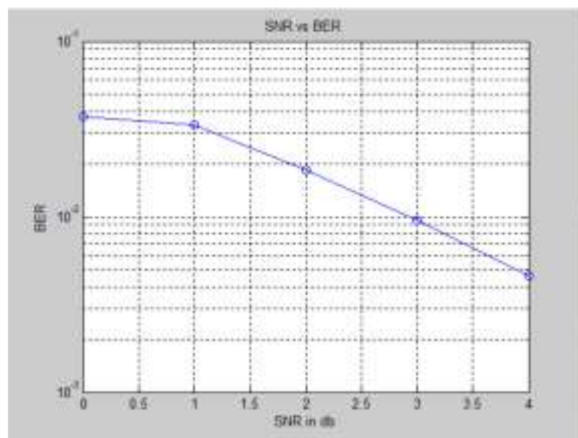
In this paper we simulate the BER vs SNR of the high priority signal (i.e) basic layer signal of our proposed algorithm .By implementing this particle filter algorithm in the hierarchical modulation we achieve the low BER with very low SNR,when we transmit a data using QPSK modulation we can acheive low BER with high SNR so it cover the farthest region but data rate will go down in order to equivalance both data rate as well as coverage area we moving for layered modulation.



Fig(5): BER vs SNR of qpsk



Fig(6): BER vs SNR of LDPC for the basic layer of QPSK+16QAM which includes particle filtering



Fig(7): BER vs SNR of LDPC decoding which does not includes particle filtering

Conclusion

This paper has presented the generation of HM signal by superimposing both basic and secondary layer signal, by exploiting the structure information on the secondary layer, the proposed decoding algorithm effectively mitigates the ILI for the basic layer in HM reception without decoding the other layers. Numerical results from simulations and a real-world digital radio broadcasting system are provided to illustrate the efficacy of the proposed technique

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