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Optimization of training sequence based sparse channel estimation for mm wave communications in 5G

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Abstract
In this paper to achieve higher data rates with high spectral efficiency and high accuracy we designed training sequence sparse channel estimation based on BAT, Cuckoo and Firefly algorithms. By using the above techniques we design a Training sequence channel estimation to reduce the bit error rate, mean square error and accurate recovery of data. The firefly optimization is the promising technique to reduce the bit error rate and to increase the signal to noise ratio to achieve high spectral efficiency Gbps.

Keywords: quadrature amplitude modulation, bit error rate, signal to noise ratio

1. Introduction

The main limitation of 5G is less bandwidth. In order to improve bandwidth the important requirements of 5G technology is to use large band of spectrum. So MM Wave Communication comes into existence. Since MM Wave communication has several advantages such as security, Limited Intercellular Interference and low transmission latency. MM Wave communication is a promising technology for 5G communications. Applying mm Wave communication to massive MIMO-OFDM is one of the alternatives to 5G communications. Since massive MIMO enhances the system capacity. Any communication application with 5G technology requires accurate channel estimation to achieve high data rates [1]. When we add orthogonal pilot symbols the overhead will gets increased which degrades the spectral efficiency. This can be reduced by recovering the sparse signal through Compressed Sensing technique which automatically improves the spectral efficiency [2-4]. To improve the functioning of novel techniques for Channel estimation is designed for Time domain Training Sequence with at, Cuckoo and Firefly algorithms for MIMO-OFDM based mm Wave communication. This firefly method improves in many parameters such as bit error rate, correct probability of error recovery. Firefly technique minimise the training sequences obtained for various transmitting antennas. In this technique the receiver is free from Inter block interference region in the training sequence among corresponding data blocks to apply estimation of rarefied channel which improves spectral efficiency. Here we are having two blocks self coherence and relative values. We can optimize self coherence by IDFT with Cyclic extension where as cross coherence by PSO. Data transmission has galloping and this trend is expected to increase the IOT and visual signals. For solving these problems, 5G technology is used. In 5G, demand of data capacity is increasing dramatically. The objective is to expand the bandwidth spread. So MM Wave is used which contains high bandwidth and frequency is 30-300GHz and wavelength is 10mm.

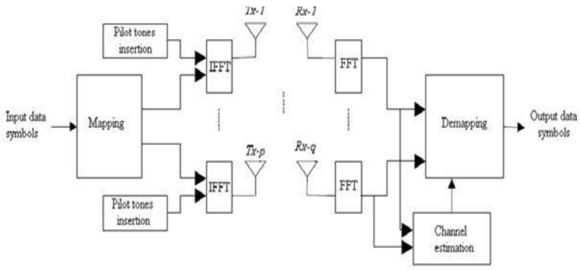

Fig 1: MIMO OFDM System Model

The advantages of MM Wave are
1. Limited Intercell-interference
2. Low transmission latency
3. Improved security

The key technology used in mm wave communication is Massive MIMO OFDM. Because, in SISO, when the data is sent from uplink to the downlink there will be a loss in the data as only one antenna is used. It receives some information and it cannot receive some of the information as it gets reflected by trees, buildings etc. The technology used in SISO is FDM [5]. In this, the communication used is serial communication. So there is delay in the transmission of the bits. Due to this, the bit error rate increases and signal to noise ratio decreases. These 2 problems can be overcome by using MIMO OFDM technology.
In MIMO OFDM technology, multiple antennas are used and the bits are transmitted orthogonally. When the bits are transmitted from uplink to the downlink, there is loss in information which is less compared to SISO technology. To further reduce that error rate we are using cuckoo algorithm.
In this algorithm we are using 2 matrices and pilot symbols are the inputs to the initial matrix. From this minimum and maximum information is calculated. Maximum information means the maximum number of solutions i.e., the initial matrix. Minimum matrix is the matrix of best solutions after the algorithm is performed. Using the minimum matrix we calculate the BER and SNR.

In general, the optimization technique can be swarm intelligence based on bio inspired (but no SI based), physics/chemistry based on by other methods such as simulated annealing. Broadly others can be attraction base or non attraction base. Again, updating systems can divide these in to related based or equation based. For example GA does not explicitly have equation for crossover. PSO, FA comes under SI based. Nature inspired or bio inspired (but not SI base) includes Flowers algorithm & pollination algorithm. In all the Meta heuristic algorithms, intensification or exploitation and diversification or exploration is adopted. For example, in firefly case, brightness is proportional the value of objective function maximized. Light intensity variation & attractive variation been the key factor. In bat algorithm frequency of 20-500 KHz correspond to 0.7mm to 17mm of wavelength. In stochastic global search, leavy factor is added in the algorithm. In comparison with integer programming or linear programming Meta heuristic methods have objective functions which are acquired by simulation through intensification and diversification. These algorithms with physics and chemistry base do not belong to bio inspired category but are nature based. Similarly Swarm intelligence based algorithms can be termed as bio inspired or nature inspired in general categorization.

2. Cuckoo algorithm

The PSO parameters are initially defined. The PSO parameters are basically the number of transmitting antennas, PSO input symbols, number of receiving antennas, channel length, pilot frequency, pilot constellation, cyclic prefix. QAM modulation at transmitter and receiver side is performed. Mapping between transmitter and receiver to be done and then convert data from serial to parallel form. Data is generated using PSO input symbols and no. of antennas [9-10]. Again conversion is done to data present. Inverse Fast Fourier transform is performed and cyclic prefix initiates, generate a random channel which adds noise. Demodulation is done at the receiver side.

If data is present at the receiver side perform cuckoo algorithm optimization technique to diminish the BER and improve the SNR at the receiving side.

In cuckoo algorithm two matrices are generated, One at the initial stage with all types of solutions which is called as maximum matrix i.e., the matrix which contains maximum number of solution. Then using cuckoo algorithm we reduce the solution to minimum number of solutions i.e., reducing to the best solutions by checking all the pilot symbols. Using the best solution matrix we determine the bit error rate and signal to noise ratio.

- **Step 1:** Initialize the PSO parameters such as Input Symbols, No. of transmitting antennas, Channel length, pilot frequency and pilot constellation.
- **Step 2:** Check whether data is present or not.
- **Step 3:** If yes then calculate FFT with CP, If No again initialize PSO data.
- **Step 4:** After step 3 Perform demodulation analyses with recovery data.
- **Step 5:** Again check the data, if No again repeat step 4
- **Step 6:** If yes then perform different matrix Analysis with Similarity/ Individuals.
- **Step 7:** Evaluate maximum search space
- **Step 8:** Calculate the results and do the post processing.

3. Bat algorithm

Define the PSO parameters. The PSO parameters are number of transmitting antennas, PSO input symbols, number of receiving antennas, channel length, pilot frequency, pilot constellation, cyclic prefix. Perform QAM modulation at transmitter and receiver side. Mapping between transmitter and receiver to be done and then convert data from serial to parallel form. Generate data using PSO input symbols and no. of antennas. Then again convert to serial form. If data present perform inverse Fast Fourier transform and add cyclic prefix. Generate a random channel and noise is removed. Perform demodulation at the receiver side [9-10]. If data is present at the receiver side perform bat, algorithm optimization technique to diminish BER and improve SNR at receiving side. Bat algorithm is based on the frequency of echolocation. By making the frequency of minimum information to zero and maximum information to two and initial matrix to zero, calculate the number of iterations by using the fitness function. Then it generates an output matrix if a minimum or maximum information given to the fitness function. This output, fmin is given as an input to the shaped function. Then calculate the maximum information by using the random function. From this calculate the best data which is fmin. From fmin calculate the bit error rate and the SNR.

- **Step 1:** Initialize the PSO parameters such as Input Symbols, No. of transmitting antennas, Channel length, pilot frequency and pilot constellation.
- **Step 2:** Check whether data is present or not.
- **Step 3:** If yes perform Random Transform creation, if no repeat step 1
- **Step 4:** After step 3 Perform demodulation analyses with recovery data.
- **Step 5:** Again check the data, if No again repeat step 3
- **Step 6:** If yes then do the maximum no of iterations adjusting frequency.
- **Step 7:** Assign ranking to the bats and find Current Bats data.
- **Step 8:** Calculate the results and visualization for current bats.

Location for sound can be done in two ways-for gases of atmosphere on water on soil and rocks. In case of active determination sound is erected such that echo is produced. This echo is used to find the accurate location. In passive method detection of sound is imperfect. Passive and active sonars utilize this method. Microphones are used in mirrors and dishes in passive study. For active case, speakers are used In case of more than one device there is chance of triangulation it is assumed that no training is used in estimating the time delay. The frequency used is from 20 KHz to 500 KHz. The main advantages are that it is convenient and ease to apply. It solves a wide range of problems with nonlinearity.

The loudness of amplitude & phase emission rates provides a mechanism for automatic control and automatic zooming. The demerit is that of the algorithm is used to switch to exploitation stages, stagnation may take place.

4. Firefly algorithm

The PSO parameters are defined. The PSO parameters are number of transmitting antennas, PSO input symbols, number of receiving antennas, channel length, pilot frequency, pilot constellation, cyclic prefix. QAM modulation is performed at transmitter and receiver side. Mapping between transmitter and receiver to be done and then convert data from serial to parallel form. Generate data using PSO input symbols and no. of antennas. Then again convert to serial form. If data present perform inverse Fast Fourier transform and add cyclic prefix. Generate a random channel and noise is removed. Perform demodulation at the receiver side. If data is present at the receiver side perform firefly algorithm optimization technique to diminish BER and to improve the SNR at receiving end by using hardmard transformation [9-10]. Then calculate the light intensity determined absorption coefficient and the maximum no of generation which is denoted as ans. This ans value helps in computation of BER and SNR.

- **Step 1:** Define PSO parameters such as Input Symbols, No. of transmitting antennas, Channel length, pilot frequency and pilot constellation.
- **Step 2:** Check whether data is present or not.
- **Step 3:** If yes perform Random Transform creation, if no again initialize new PSO input parameters
- **Step 4:** Perform demodulation analysis with recovery data.
- **Step 5:** Again check the data, if it is yes then calculate light intensity determined by absorption coefficient, generate maximum generations.
- **Step 6:** Compute post process for these generations
- **Step 7:** If No again repeat the step 4.

5. Results & Discussions

For optimization of sensing matrix in the field of degree of coherence specific training sequence is designed and computed by considering factors like self coherence and mutual coherence. IDFT is taken for the series related to frequency. Block coherence can be significantly reduced by such optimization. The traditional design is improved taking factors like BER & MSE. The compressed sensing theory is used to recover sparse signal depending on minimum observation. As the distinct multiple develops are less compared to channel delay. Impulse response becomes a special vector. The compressing theory is application for estimation in case of channels.

The techniques of optimization makes the inter block free area in the sequence between data blocks to determine the estimation. Through the data of the spatial correlation of various channels, a sparse model for blocks can be adopted so that structured compressing can be achieved. By this the spectral efficiency can be achieved. By this the spatial efficiency is increased. In many estimation techniques time based sequences and frequency based pilots can be utilized...The ultimate overhead increase as the transmission devices increase. Spectral efficiency is affected. For improvement, optimization techniques are suitable in circumventing the problem of conventional system. The values of the parameters taken are PSO input symbols =10-3, No. of antennas=64, PSO Constellation=8, Pilot Frequency=8, Pilot Energy=8, Cyclic Prefix=8, Length Taps=8.

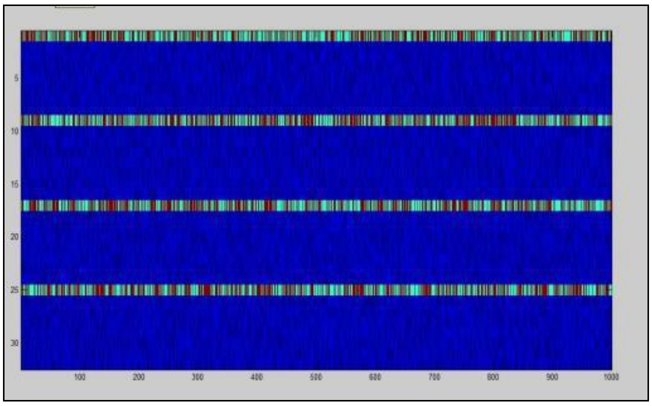

Fig 2: Training Sequence

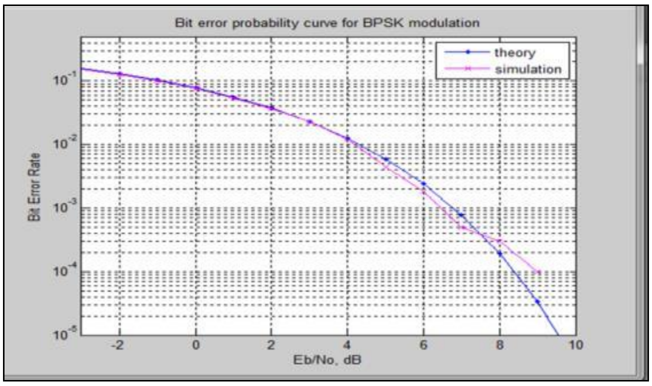

Fig 3: Bit error rate gradually decreases with the probability curve for BPSK modulation

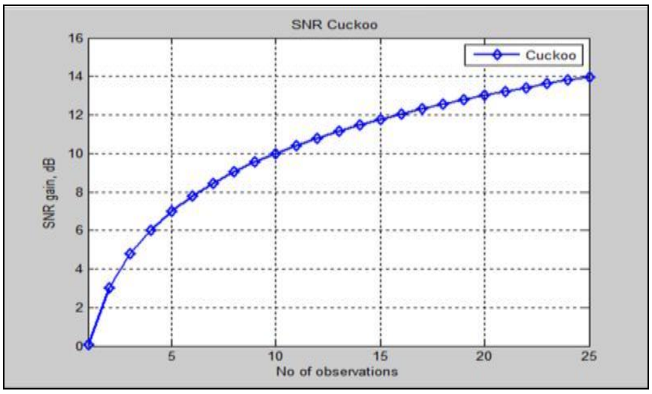

Fig 4: As the number of observations get increased the SNR gain increases effectively

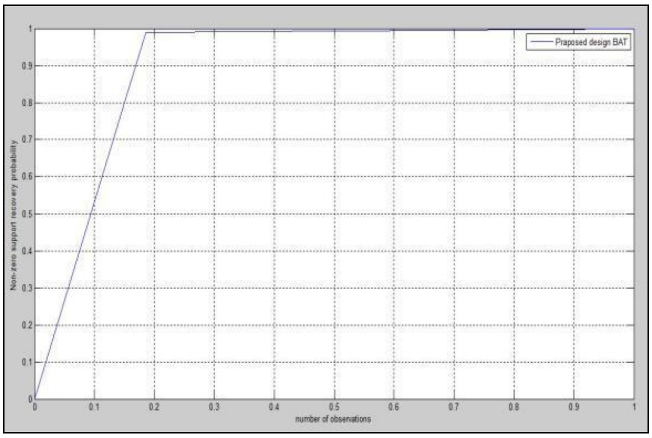

Fig 5: As No of Observations increases the Block coherence value converges to Zero

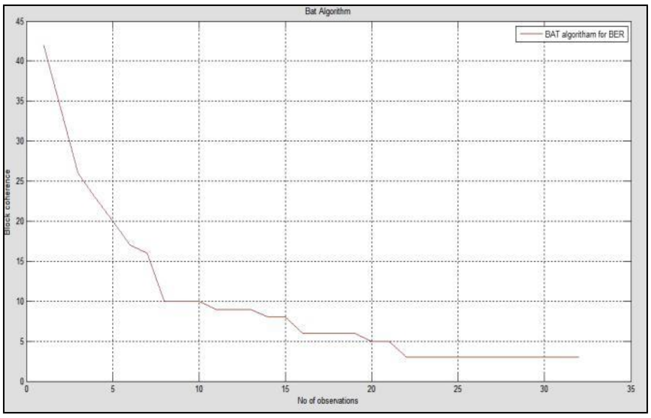

Fig 6: Observation of Signal to Noise Ratio

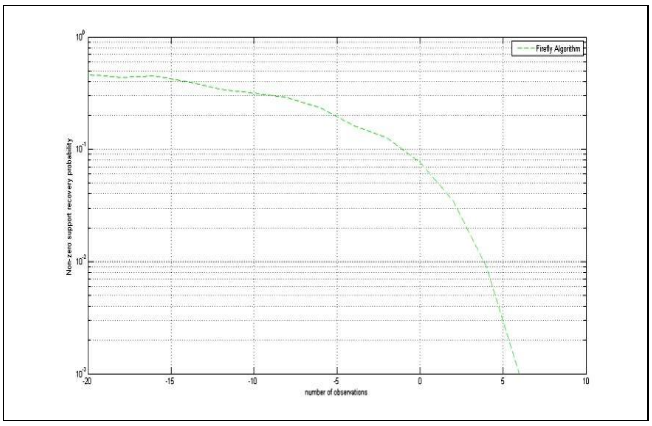

Fig 7: Error probability gradually reduces with number of observations

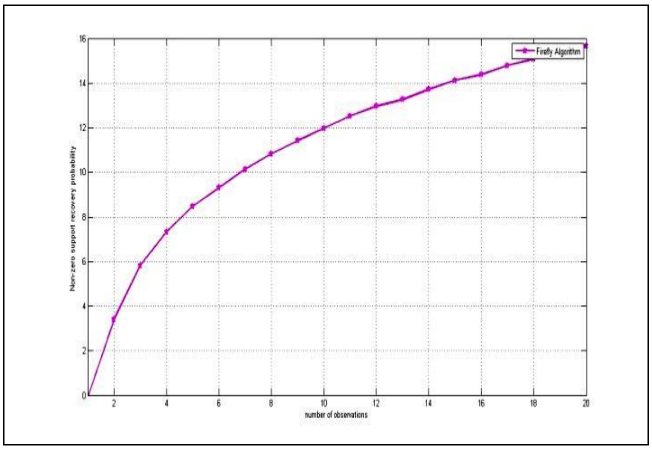

Fig 8: SNR is increased with number of observations

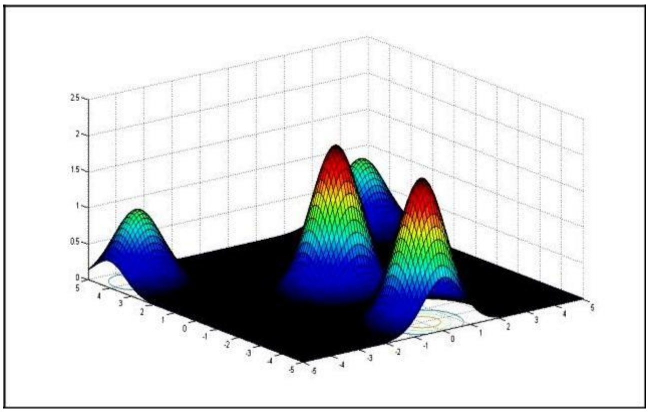

Fig 9: Observation of intensity levels

Table I: 5G

Algorithm	BER	SNR
Bat	3	1
Cuckoo	10^{-3} for 8 observation	14
Firefly	10^{-3} for observation s	15

Performance comparison of different algorithms:

6. Conclusion

Fire fly algorithm is better when compare to bat and cuckoo algorithms. Here in bat algorithm BER reduces to 3 and SNR (signal to noise ratio) increases to 1dB, similarly in cuckoo algorithm BER reduces to 10-2 times and SNR increases to 14dB.In firefly algorithm BER reduces to 10-3 and SNR increases to 16dB.

Hence firefly algorithm is best algorithm compared to bat and cuckoo algorithms as SNR has been increased and BER has been decreased. It is well known swarm-based algorithms which have been accepted in many applications. The main advantage is that it is quite easy to comprehend. There are many nature-inspired algorithms some are Swarm inspired and others are bio inspired. The scheme suggested in this paper is an attractive physical layer technique for the mm Wave communications which would find application in 5G communications for overall improvement of the system including favorable pattern.

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