Hybrid Evolutionary Algorithm Based on PSO to Reduce Non linear effect for 802.11a High Speed Network

Er. Sahibinder Singh [1], Er. Devesh Mahor [2]
[1]Deptt.Of Electronics and Comm., S.R.I.E.T, URJANI
[2] Deptt. of Electronics and Comm., M.M.U, MULLANA
[1]er.sahibinder@gmail.com
[2] mahor.devesh@gmail.com

--ABSTRACT---
A high speed network 802.11a (OFDM) has emerged as very popular wireless transmission technique in which digital data bits are transmitted at a high speed in a radio environment. But non linear effect (PAPR) is challenge of high speed based communication that has recently drawn much attention. Non linear effect in 802.11a causes nonlinear distortions after amplified by power amplifier. Many methods proposed to reduce PAPR. In this article, we introduce a low-complexity partial transmit sequence (PTS) based on particle swarm optimization (PSO) algorithm is presented for the low computation complexity and the reduction of the peak-to-average power ratio (PAPR) of an 802.11a wireless standard. In this paper, we work around potentially computational intractability; the proposed PSO scheme exploits heuristics to search the optimal combination of Cumulative Distribution Function (CDF) with low complexity. Simulation results show that the new technique can effectively reduce the computation complexity and PAPR reduction.

Keywords: OFDM, PAPR, PSO, CDF.

INTRODUCTION:

Over the last two decades, wireless communications have been excitedly accepted by the world's population at large, to become an essential tool in our day-to-day lives. In an OFDM scheme, a large number of orthogonal, overlapping, narrow band sub-channels or subcarriers, transmitted in parallel, divide the available transmission bandwidth. The separation of the subcarriers is theoretically minimal such that there is a very compact spectral utilization. The attraction of OFDM is mainly due to how the system handles the multipath interference at the receiver. Multipath generates two effects: frequency selective fading and intersymbol interference (ISI). The "flatness" perceived by a narrow-band channel overcomes the former, and modulating at a very low symbol rate, which makes the symbols much longer than the channel impulse response, diminishes the latter. Using powerful error correcting codes together with time and frequency interleaving yields even more robustness against frequency selective fading and the insertion of an extra guard interval between consecutive OFDM symbols can reduce the effects of ISI even more. Thus, an equalizer in the receiver is not necessary.

There are two main drawbacks with OFDM, the large dynamic range of the signal (also referred as peak-to average [PAR] ratio) and its sensitivity to frequency errors. These in turn are the main research topics of OFDM in many research centres around the world.

PAPR Problem in OFDM:

One reason why the nonlinearity of PA should be considered seriously is that the large peak power of the OFDM signal sometimes makes the

PA inefficient. When adding up subcarriers with the same phases, the peak power is N times than the average power of the signal on each subcarrier. This results in a high Peak-to-Average Power Ratio (PAPR). Such high PAPR problem associated with multicarrier signals is one of the principal drawbacks of OFDM. A high PAPR makes the PA work with large IBOs, resulting in inefficient use of the amplifier. High PAPR also increases the complexity of the ADC and DAC [21]. The PAPR is defined as:

$$PAPR = \frac{\max_{0\leq t\leq T} \mid x(t) \mid^2}{E[\mid x(t) \mid]^2} \quad \text{------(2.1)}$$

Where max0<t<T │ x(t) │2 is the maximum power of the signal and E[│ x(t) │2] is the average power. Another factor used is the Crest Factor (CF) which is defined as the square root of PAPR:

$$CF = \frac{\max_{0\leq t\leq T} \mid x(t) \mid}{E[\mid x(t) \mid]} \quad \text{--------(2.2)}$$

From Eq. (2.1), it can be seen that the high PAPR can be reduced either by reducing the maximum signal power or by increasing the average power. In reality, reducing the maximum signal power is used in most cases because increasing the average power causes more interference. Although there are many techniques for reducing high PAPR, all these approaches have some corresponding disadvantages, such as signal distortion and complexity of the implementation. These approaches also cannot guarantee that the signal after processing can avoid PA nonlinear distortion. Here we use PSO technique for reduction of PAPR.

Introduction to PSO:

Particle Swarm Optimization was firstly introduced by Dr. Russell C. Eberhart and Dr. James Kennedy in 1995. As described by Eberhart and Kennedy [22], PSO algorithm is a population based search algorithm based on the simulation of the social behaviour of birds within a flock. The initial intent of the particle swarm concept was to graphically simulate the graceful and unpredictable choreography of a bird flock, with the aim of discovering patterns that govern the ability of birds to fly synchronously, and to suddenly change direction with a regrouping in an optimal formation. From this initial objective, the concept evolved into a simple and efficient optimization algorithm.

PSO Algorithm.

In PSO, individuals are referred to as particles, which are “flown” through hyper dimensional search space [24]. Change in the position of each particle within the search space is based on the social psychological tendency of particle to emulate the success of other particle. The change to a particle’s position within the swarm is therefore influenced by the past experience, or by the knowledge of its neighbours. The search behaviour of a particle is thus affected by that of other particles within the swarm (PSO is therefore a kind of symbiotic cooperative algorithm). Particle Swarm optimization technique has mainly two primary operators:

- Velocity update
- Position update

During each generation each particle is accelerated toward the particle’s previous best position (pbest) and the global best (gbest) position and new velocity value for each particle is calculated based on:

✓ Its current velocity.
✓ The distance from its previous best position.
✓ The distance from the global best position.

The new velocity value is then used to calculate the next new position of the particle in the search space. In PSO, initially each potential solution is assigned a randomized velocity and is “flown” through the problem space. Each particle adjusts its flying according to its own flying experience and its companion flying experience.

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$$v_i^{t+1}=w.v_i^{t}+c_1.[pbest_i^{t}-]+c_2.[gbest-] \quad \text{-------(3.1)}$$

$$x_i^{t+1} = x_i^{t} + v_i^{t} \quad \text{------------------(3.2)}$$

Where;
v_i^t is velocity of i^{th} particle at iteration t,
w is weight inertia.
c_1, c_2 is Acceleration Constants.
r_1, r_2 is random number between 0 and 1.
x_i^t is current position of i^{th} particle at iteration t,*pbest*$_i$ is personal best of i^{th} particle.

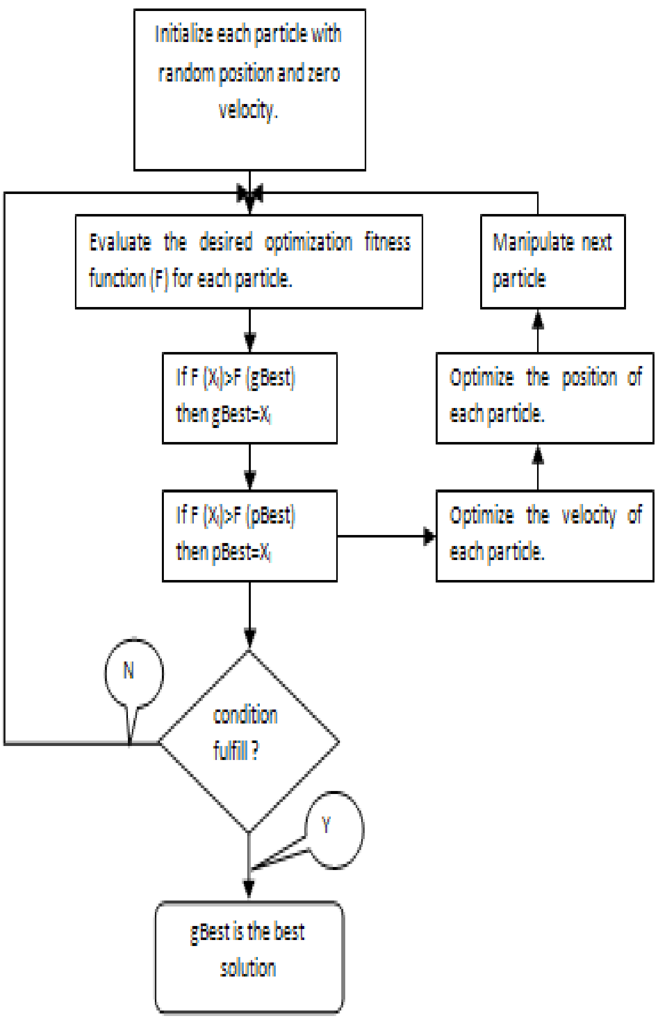

FIG:3.1 Flow diagram of PSO

Table 3.1: PSO Procedure

```
Repeat
 for i = 1 to number of particles do
    if G(Xi) > G(pbesti) then G() evaluates goodness
       for d = 1 to dimensions do
       pbesti = Xi   // pbesti is the best state found so far
       end for
    end if
      gbest = i        // arbitrary
    for j = indexes of neighbours do
      if G(pbestj) > G(gbest) then
      gbest = j   // gbest is the index of the best performer in the
                       neighbourhood
      end if
    end for
    for d = 1 to number of dimensions do
       Vi^t = f (Xi^(t - 1), Vi^(t - 1), pbesti, gbest)  //Update velocity
       Vi □ (-Vmax, + Vmax)
       Xi^t = f (Vi^t, Xi^(t - 1))     //Update position
    end for
    end for
       until stopping criteria
    end procedure
```

RESULTS AND SIMULATION PERFORMANCE:

CUMULATIVE DISTRIBUTION FUNCTION

The Cumulative Distribution Function (CDF) is one of the most regularly used parameters, which is used to measure the efficiency of any PAPR technique. Normally, the Complementary CDF (CCDF) is used instead of CDF, which helps us to measure the probability that the PAPR of a certain data block exceeds the given threshold.

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By implementing the Central Limit Theorem for a multi – carrier signal with a large number of sub-carriers, the real and imaginary part of the time – domain signals have a mean of zero and a variance of 0.5 and follow a Gaussian distribution. So Rayleigh distribution is followed for the amplitude of the multi – carrier signal, where as a central chi-square distribution with two degrees of freedom is followed for the power distribution of the system

PARAMETERS USED FOR SIMULATION:

M=4,QPSK signal constellation

No. of data points=128

Block size=08 ,size of each OFDM Block

CP_len=ceil(0.1*block size),lenth of cyclic prefix

No.of IFFT points =block size,128 points for FFT/IFFT

No. of fft points =block size.

PAPR is a big problem as far as OFDM is concerned so a method has been implemented using PSO. Initial data has been taken while doing this experiment as follow QPSK signal constellation 4, data points 128, size of each OFDM block 8, and 128 points for the FFT/IFFT. Different number of Particles (NOP) and number of iterations (NOI) have been chosen for PSO algorithm.

Figure 4.1 Shows the discrete input data which is transmitted using OFDM.

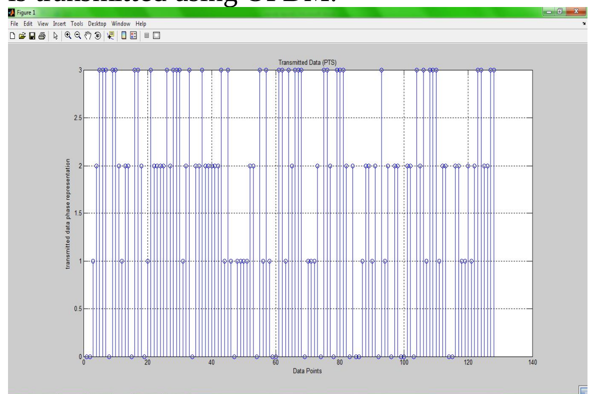


Figure 4.2 Shows the scattered plot of the transmitted QPSK modulated signal.

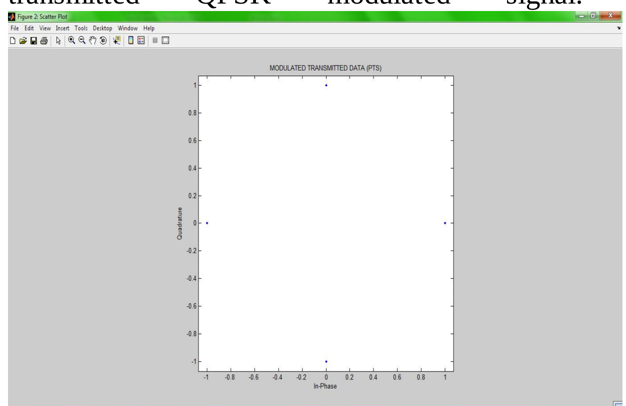


Figure 4.3 Shows the OFDM signal for the simple case which is the actual signal which transmit through the channel as only continuous signals can be transmitted.

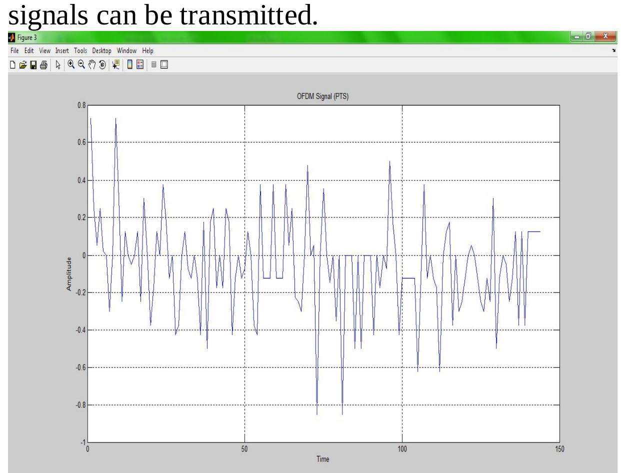


Figure 4.4 Shows the received signal for the simple case.

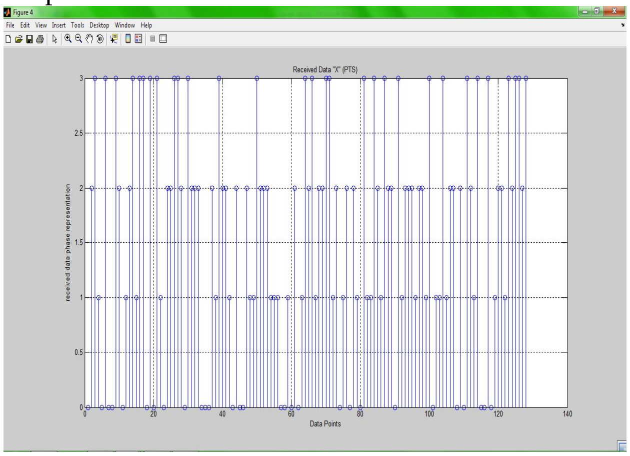


Figure4.5Shows the received signal for the PSO.

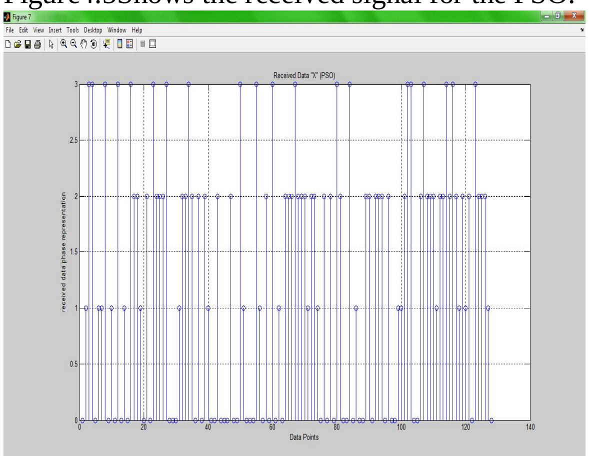


Figure 4.6 show the graph between PAPR and CDF for the number of particles and number of iteration is equal to one. Here comparison of three techniques (PTS, Clipping and filtering, proposed PSO technique) has been made on the basis of PAPR. Here for the numbers of particles and number of iteration equal to one PAPR by using PTS is 6.2, for clipping and filtering 9.1 and for PSO 10.1 for CDF equals to 0.1. So no reduction in PAPR found using PSO.

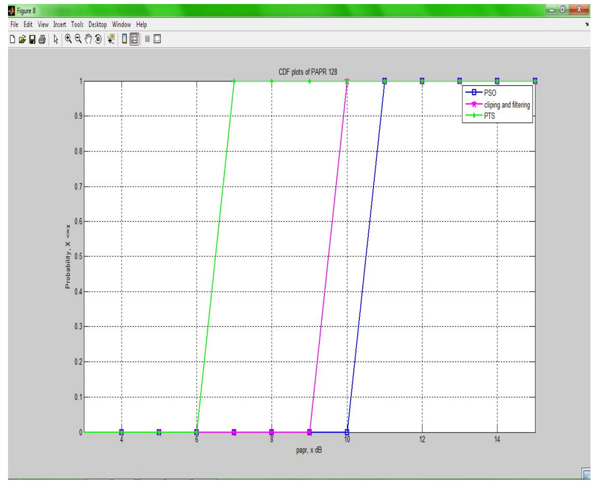
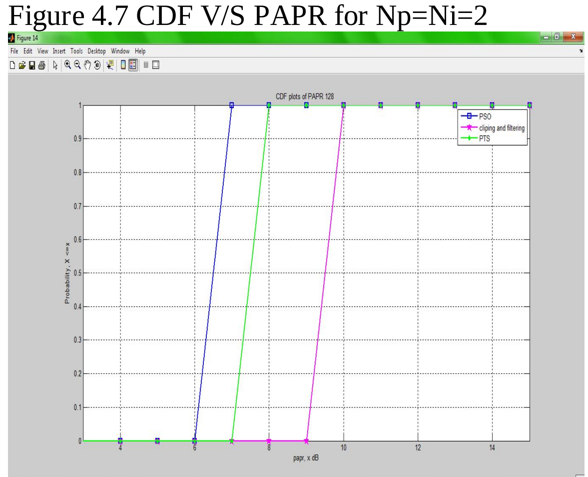


Figure 4.7 shows the graph between PAPR and CDF for the number of particles and number of iteration is equal to two. Anyone can see that for the numbers of particles and number of iteration equal to one PAPR by using PSO is 6.1, for clipping and filtering 9.1 and for PTS 7.1 for CDF equals to 0.1. So reduction in PAPR found using PSO in OFDM.

Figure 4.7 CDF V/S PAPR for Np=Ni=2



OFDM using clipping not always gave good results as far as PAPR is concern for number of particles and numbers of iteration equals to two clipping gave good results but not always. As PSO is a simple PAPR reduction technique which may be easily implemented in hardware. PTS also a good technique to reduce PAPR but need modification on transmitter as well as receiver side but PSO need on transmitter only.

CONCLUSION:

With the rising demand for efficient frequency spectrum utilization, of dm proves invaluable to next generation communication systems. To conclude, Several techniques to reduce PAPR have been proposed. In recent years, such as clipping, coding and scrambling techniques. As a scrambling technique, partial transmit sequence (PTS) is known to achieve high PAPR reduction with a small amount of redundancy. However, selecting the optimal parameters for PTS is very complex, especially when a large number of sub-blocks are used. Clipping is a good technique for the reduction of PAPR but not always because some part of signal clipped that threshold should have to be chosen properly which is generally not chosen properly. But in case of PAPR reduction using PSO there is no such limit. PAPR reduction using PSO gave good result as compared of simple and clipping technique and should have to be used in OFDM.

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Author's biography:
Er. Sahibinder Singh
Pursuing M.Tech in Electronics & Comm. Engg. From MMU, Mullana.
Working as a Lect. in Electronics & Comm. Deptt. In Shri Ram Institute of Engg. & Tech., Urjani

Er. Devesh Mahor
M.Tech in Electronics & Comm. Engg.
Working as Sr. Lect. in Electronics & Comm. Deptt. in MMU, Mullana.