Power allocation in clusters for multi-band ofdm
Generation of ofdm samples

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Index:

Abstract:

The principle of multi-carrier transmission i.e. OFDM is to convert a serial high-rate data stream onto multiple parallel low-rate sub streams. This results in a significant reduction in ISI (inter symbol interference) and complexity of the equalizer. It can adopt different modulation and signaling formats, that makes it more favorable. Here we have discussed low power allocation technique for clustered multi-band OFDM networks. The idea is to assign power to each cluster while maximizing the total throughput. The method is tested for 1.8 GHz band.

Introduction:

OFDM is a low-complex technique to efficiently modulate multiple sub-carriers by using digital signal processing. In this serial high-rate data stream is converted onto multiple parallel low-rate sub-streams. This significantly reduces the ISI and complexity of the equalizer.

Power allocation is an integral part of MAC protocol design.If the channel profile is known then water filling with adaptive modulation is the optimal solution. Here we discussed a power allocation scheme for a clustered multi-band OFDM network. Generally, in such kind of systems a chunk of bandwidth is divided into multiple sub bands. Within each sub band, OFDM is employed. In a multi-band ofdm, a chunk of bandwidth is divided into multiple sub-bands. Users share them according to assigned time frequency codes. Within each sub, band ofdm is employed, yielding 128 sub carriers among which there are 100 data tones for information transmission, 12 pilot tones, 10 guard tones and 6 reserved null tones.

Clustered OFDM is a promising technique in systems where adjacent OFDM tones are further grouped into non-overlap clusters. This clustered OFDM offers additional advantages over classical OFDM such as significantly reduced peak-to average power ratio and hardware simplicity.

In this system, only the cluster with best channel condition is chosen to transmit signal each time. How ever, in this system throughput is not optimized because only a small amount of bandwidth is used at a time. However, the system is less complex when compared to other algorithms. Hence, a trade off between complexity and performance is required. We do this by assigning a unique power for each cluster rather than each sub carrier

Implementation using Matlab:

1. Program

a)

```
% power allocation in each cluster
% made by Mayank aggarwal

BW=1.8*10^9;      %bandwidth

Pthr=.001;        %termination threshold
a=1;              %define for epsilon
v=0;              %LaGrange's equality constant
Ptot=0;           %total power in one sub-band
Ptotal=.128;      %total power given to each sub-band
Pm=.004;
D=rand(1,32)./10^4;  %power attenuation factor
alpha=(36.92*10^(-6)./D);
b=1:32;           %no. of sub-carriers in each cluster


while abs(Ptot-Pm)>Pthr    % algorithm for finding power in each cluster
   for l=1:4

         if sum(1./alpha)<=v
         Pl=0;
         else
          Vth=10^(-9);
         U=1;
         Pl=.1;


          while abs(v-sum(1./(alpha+Pl)))>Vth;
         del=sum((1./(alpha+Pl).^2).*(v-sum(1./(alpha+Pl))))
         v=sum(1./(alpha+Pl))
         Pl=Pl-del
         abs(v-sum(1./(alpha+Pl)))
```

```
            keyboard
             end
         end
         Pl(l)=Pl
          Ptot=Ptot+Pl(l)  %total power

         x=(1/v)+a*(Pm-Ptot)
         v=(1/x)
   end
     break
   end
```

b)

```
% throughput and snr
% made by Mayank aggarwal

D=rand(1,32)./10^4;
snr=rand(1,10).*10
c=log2(1+snr)
plot(snr,c)
grid
```

c)

```
% ofdm samples generation
% made by Mayank aggarwal
Nc=128;            %no. of sub carriers
Ts=128*10^(-3);    %symbol duration after conversion
Fs=1/Ts;           %symbol frequency
Tg=31*10^(-6);     %guard time
R=1.7*10^6;        %rate of transmission
Td=Ts/Nc;          %source symbol duration
s=0:127;           %no. of source symbols
Fn=s./Ts;          %Nc sub carrier frequencies

for t=1:128
```

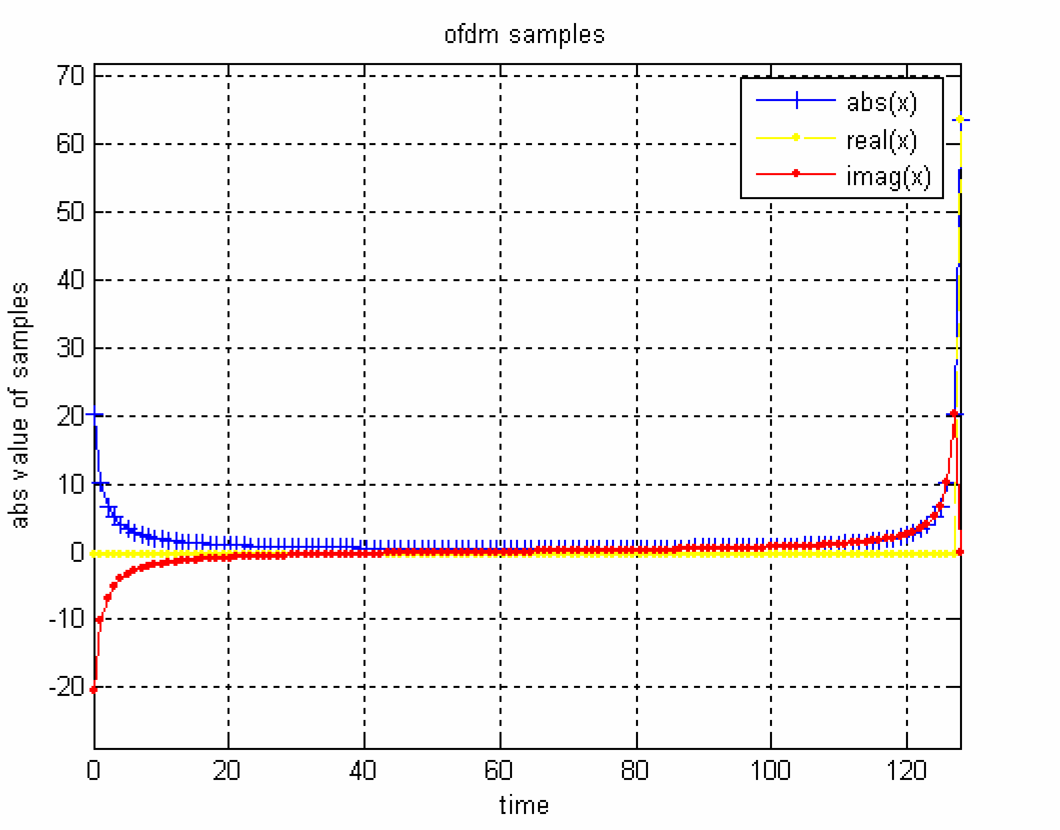
```
x(t)=(1/Nc)*sum(s.*exp(i*2*pi.*Fn*t*10^(-3)));%complex envelope of ofdm
symbols(samples produced)
end

t=linspace(0,128,128);

plot(t,abs(x),t,real(x),'--.y',t,imag(x),'-r.')
xlabel('time');
ylabel('abs value of samples');
title('ofdm samples');
legend('abs(x)','real(x)','imag(x)')
axis('equal')
```

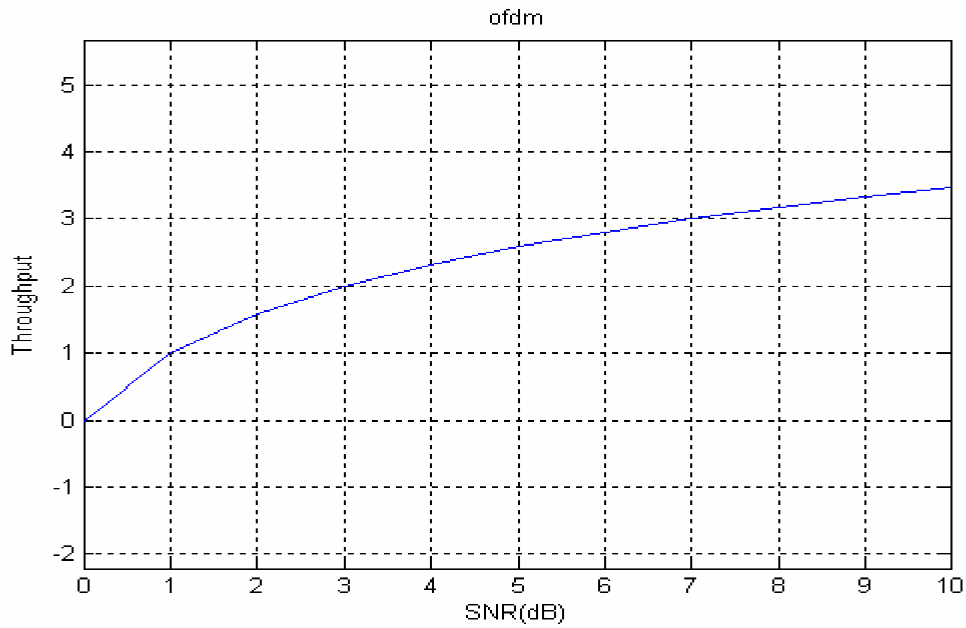
d)

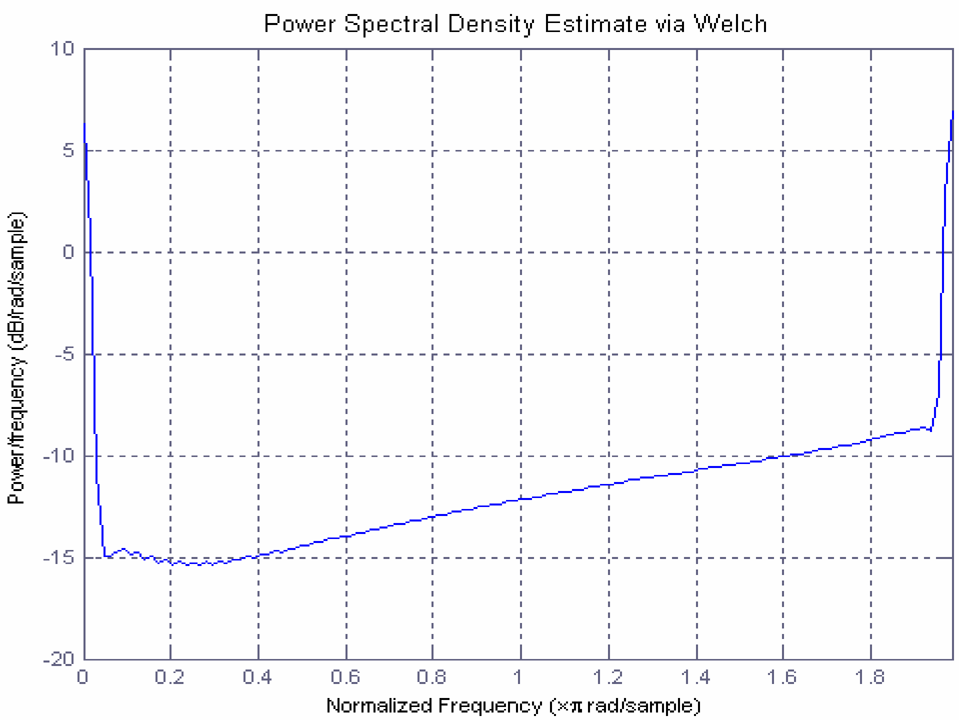
```
% ofdm power plot using spectrum. Welch
% made by Mayank aggarwal
Nc=128;             %no. of sub carriers
Ts=128;    %symbol duration after conversion
Fs=1/Ts;         %symbol frequency
Tg=31*10^(-6);     %guard time
R=1.7*10^6;        %rate of transmission
Td=Ts/Nc;          %source symbol duration
s=0:(Nc-1);        %no. of source symbols
Fn=s./Ts;          %Nc sub carrier frequencies
t=1:12;            %conversion time
%subplot(3,1,1)
theta=linspace(0,2*pi,128);
y=5.*sin(theta);   %plot of input sample
%plot(theta,y)
for t=1:128
x(t)=(1/Nc)*sum(s.*exp(i*2*pi.*Fn*t));%complex envelope of ofdm symbols(samples
produced)
end
clf
h = spectrum. Welch;
```

psd(h,x);

2. Plots




ofdm
Throughput
SNR(dB)
5
4
3
2
1
0
-1
-2
0
1
2
3
4
5
6
7
8
9
10


Power Spectral Density Estimate via Welch
Power/frequency (dB/rad/sample)
Normalized Frequency (×π rad/sample)
10
5
0
-5
-10
-15
-20
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8

Conclusion

In this project, we presented a power allocation algorithm for clustered multi band OFDM UWB networks. System throughput is maximized with respect to cluster powers under a total power constraint. Compared with other algorithms, it has low complexity but close performance. It outperforms an existing power allocation method that selects only one best cluster each time.

References:

Getting started with matlab: by RUDRA PRATAP

IEEE paper: power allocation for OFDM

Multi band communications: by

http://ieee802.org/15/pub/TG3.html