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Performance Analysis of Adaptive Algorithms in Future Cellular Networks Using MATLAB

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Abstract: *Future cellular communication systems will be designed to support a wide ranges of data rates, high data coverage, larger capacity and challenging throughput with a complex quality of service matrix. It is becoming more challenging to optimize the radio resource management and maximize the system capacity by meeting the required quality of service from user's point of view. This paper addresses the influence of multi-cell interference, BER, path loss and the effect of QAM on overall radio communication. This project sets a new direction for future research on resource scheduling strategies in a multi-cell system. We can achieve all above requirements by introducing a new concept of digital fixed relays i.e. six digital fixed relays all located in each cell in a hexagonal manner. The proposed algorithm (adaptive algorithm) performance can be investigated for many variables of the cellular system viz.. number of users, cell size, band width, relay location, transmit power, propagation parameters….etc. By varying these we can analysis the performance of a cellular system.*
Keywords: *Cellular system, Bit Error rate, qudrature ampliyude modulation, path loss, digital relay, Constellation diagram.*

I. Introduction

MOBILE cellular systems are facing new challenges created by the demand for emerging services and applications. Even as the technology developing the number of users using cellular systems is emerging in large geographic area, but the given frequency spectrum is minimum. In order to utilize given frequency band very efficiently and effectively there are several technological developments in the offing. One way is by decreasing the coverage of each base station transmitter we can achieve high capacity namely, frequency reuse concept in cellular communication. Using adaptive algorithm in our project the system changes its behavior based on its input (parameters) changes i.e. cell size, number of user in a cell , transmitted power, relay location…etc.

II. Important Parameters In Cellular System

In practice, the following parameters are most important while considering the cellular communication

a. Cell size,
b. Number users per cell,
c. Co-channel reuse ratio,
d. Path loss,
e. Transmitted power,
f. Signal to noise ratio,
g. Bit error rate,
h. Modulation technique(QAM),
i. Frequency re use,
j. Relay response,

A. Cell size

The user capacity of cellular networks can be increased by reducing cellular networks. Macro cellular networks are designed for use over large distances and may be too bulky power consuming but conveniently portable. Cell size is more in macro cellular networks.
Pico and micro cellular networks are often used where the cell size is less. In this cellular network slow transmit power (<20mw). It can be used in this network

Ranges of networks:
Macro cellular network, with cell range: 1 to 30 km
Micro cellular network, with cell range: 200m to 2km
Pico cellular network, with cell range: 4 to 200 m

Decreasing cell size gives improved user capacity. But the increased number of handovers per cell increases the complexity and locating the subscriber. Lower power consumption in mobile terminal so it gives longer talk time, safer operation.

Matlab Program:

```
clear all;
x_hexagon=[-1 -0.5 0.5 1 0.5 -0.5 -1];
y_hexagon=[0 -sqrt(3)/2 -sqrt(3)/2 0 sqrt(3)/2 sqrt(3)/2 0];
N=10;
M=10;
figure(1)
hold on
for nn=0:N
for mm=0:M
plot(x_hexagon+3*nn,y_hexagon+sqrt(3)*mm)
 end
end
for nn=0:N-1
for mm=0:M
plot(x_hexagon+1.5+3*nn,y_hexagon+sqrt(3)/2+sqrt(3)*mm)
 end
end
hold off
axis equal
```

III. Result

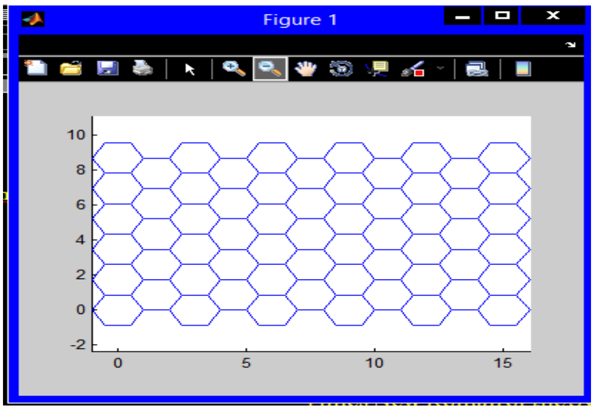

Fig:1 cellular system design

A. Co-channel reuse ratio(Q)

Co-channels are nearby channels with the same frequency   Co-channel interference causes

1. Voice Channels: Loss of quality
2. Control Channels: Dropped calls

Increasing SNR does NOT solve co-channel interference (in fact, it can make it worse) Reduce co-channel interference by increasing distance between co-channels

R = radius of each hexagonal cell

D = distance between canters of cells

Q = co-channel reuse ratio = D/R = sqrt(3N) for hexagonal cells. Small Q increases system capacity (N is small). Small Q increases co-channel interference (less distance between cells)

Large value of Q improves the transmission quality.

Matlabcoading

```
clc;
clear all;
close all;
N=input('enter the cluster size [N]=');
Q=sqrt(3*N)
```

RESULT

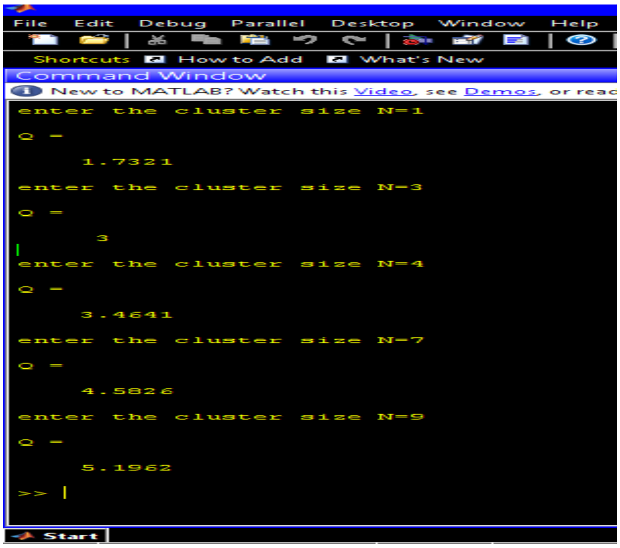

Fig - Co-channel reuse ratio(Q)

Path loss:
Path loss models describe the signal attenuation between a transmitter and a receiver antenna as a function of the propagation distance and other parameters.

<u>Linear path loss:</u>
The signal transmitting with the power P(t) from the channel and the receiver receives the signal of power p(r).linear path loss defines the ratio of transmitter power to receiver power

$$P_L = \frac{P_t}{P_r}$$

<u>Effects</u>:
- Reflection
- Diffraction
- Scattering
- Absorption

<u>Path loss formulae</u>:

$$L = 10\ n\ \log_{10}(d) + C$$

n = path loss exponent
d = distance between transmitter and receiver
c = constant which account for system loss.

Matlab Program:
```
%%% simulation of the first algorithm for N=4;
clear all;clc
R=2;
Ps=10; %% 10 watt
Pn=1.3;
N=4;
prel=[10^-5 0.1 0.3 1];
%%%% path loss algorithm %%%%%%%%%%%%%%%%%%%%%%%%%%
for i=1:length(prel)
B(i)=10*log10(Ps/prel(i));
PI1=(N)*prel(i)*1/R
if abs(Ps-B(i))~=0
P(i)=min([PI1 abs(Ps-B(i))]);
else
```

```
P(i)=PI1;
end
end
plot(prel,P,'bx-');hold on;
ylim([0 4]);grid on;
%%% simulation of the first algorithm for N=7;
N=7;
prel=[10^-5 0.1 0.3 1];
for i=1:length(prel)
B(i)=10*log10(Ps/prel(i));
PI1=(N)*prel(i)*1/R
if abs(Ps-B(i))~=0
P(i)=min([PI1 abs(Ps-B(i))]);
else
P(i)=PI1;
end
end
plot(prel,P,'rx-');hold on;
ylim([0 4]);grid on;
title('path loss of a cellular system at N=4');
xlabel('distance')
ylabel('path loss in [db]');
legend('pathlossn=4','pathloss n=7')
```

RESULT

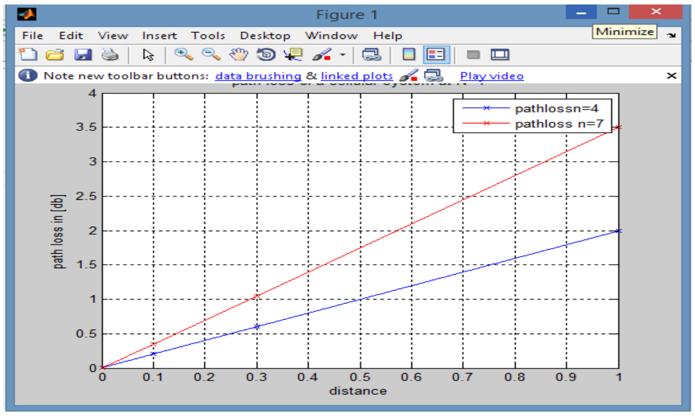

Fig- path loss effect

A. Modulation technique (QAM)

QAM widely used for radio communications because it has major advantages over other modulation techniques. In QAM Two carrier signals are phase shifted by 90 degrees are modulated. Now the resultant output signal consists of both amplitude and phase. When QAM is used for digital transmission for mobile communication applications it should be able carry high data rates than other modulated schemes. In QAM based on modulation format it has some points on constellation diagram. For example 32 QAM has 32 points constellation diagram. If use higher order QAM it is possible to transmit more number of bps (bits per symbol). High order QAM is used when we have sufficiently high signal to noise ratio. The advantage of moving to higher order formats is that there are more points within the constellation and therefore it is possible to transmit more bps (bits per symbol). The downside is that the constellation points are closer together and therefore the link is more susceptive to noise.

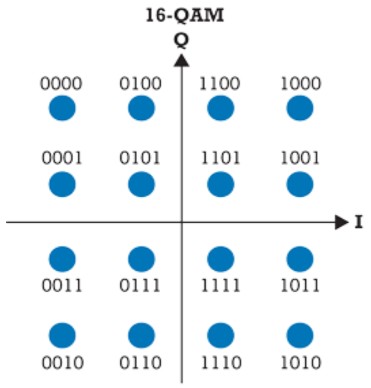

Fig- Constellation diagram (16QAM)

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1xbit rate
QPSK	2	1/2x bit rate
8PSK	3	1/3xbit rate
16QAM	4	1/4xbit rate
32QAM	5	1/5xbit rate
64QAM	6	1/6xbit rate

Table-1 comparison of different modulation techniques

MODULATION	BITS PER SYMBOL	ERROR MARGIN		COMPLEXITY
OOK	1	½	0.5	LOW
BPSK	1	1	1	MEDIUM
QPSK	2	1/1.414	0.71	MEDIUM
16QAM	4	1.414/6	0.23	HIGH
64QAM	6	1.414/14	0.1	HIGH

Table-2 comparison of different modulation techniques

A. **SINR:**

MATLAB PROGRAM:

```
%%% simulation of the first algorithm for N=4;
clear all;clc
R=2;
Ps=10; %% 10 watt
Pn=1.3;
N=4;
prel=[10^-5 0.1 0.3 1];
for i=1:length(prel)
PI1=6*prel(i)*1/R;
S(i)=Ps/(Pn+PI1);
bs=Ps*1/R;
Sr(I )=max(S(i),bs);
end
plot(prel,N./Sr,'kx-');hold on;
ylim([0 4]);grid on;
%%% simulation of the first algorithm for N=7;
N=7;
prel=[10^-5 0.1 0.3 1];
for i=1:length(prel)
```

```
PI1=6*prel(i)*1/R;
S(i)=Ps/(Pn+PI1);
bs=Ps*1/R;
Sr(i)=max(S(i),bs);
end
plot(prel,N./Sr,'rx-');hold on;
ylim([0 4]);grid on;
 title('Avereagespeactraleffciency at N=4');
xlabel('Relay tramitted power')
ylabel('Average spectral effciency per user');
legend('SINR at N=4','SINR at N=7')
```

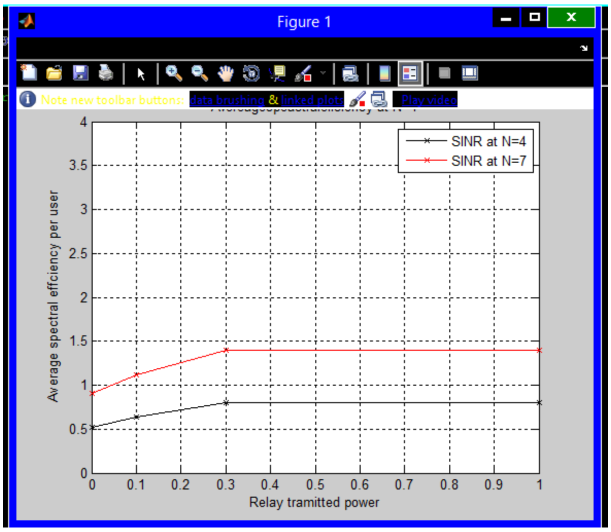

Fig- Response of SINR

A. Bit Error Rate

BER (bit error rate) is used to quantify the channel by counting the number of error bits. BER is very important parameter in any digital communication to assessing systems. When digital data is transmitted there is possibility of getting errors. If errors are came into the data then the integrity of the system may be compromised. For an ideal communication system BER should be zero for a good system BER should be as small as possible. If the channel between Ty and Rx is good and the signal to noise ratio is high then the BER will be very small. BER also be calculated through probability of error (POE) to calculate BER through POE we need to find ERF, energy in one bit (E_b), noise power spectral density (N_o). Different types of modulation has different value of error function.

IV. Conclusion

The concept of adaptive algorithm in future cellular communication using MATLAB software would be helpful for the analysis of cellular networks and also for the designers to rectify the errors and build the system in a cost effective manner before the actual implementation of cellular system. As future scope we plan using these adaptive algorithms for cellular system design and for calculate the path loss, co-channel interference ratio(Q), transmitted power, SNR, BER …etc. As a group we can use these entire coding as a cellular communication tool box in MATLAB software.

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