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Smart WCDMA FDD Downlink System with Constant Modulus Algorithm: Depreciates The Mobile Radiation Effect on Human and Convalesces System Performance

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Bodavula Lokesh Phani
B-tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

Akula Yogesh
B-tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

Lanka Jyothi
B-tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

Ballem Uma Kiranmayee
B-tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

Balagam Sindhura
B-tech, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

Dr. Chava Santhi Rani
Professor, Electronics and Communication Engineering, DMS SVH College of Engineering, Machilipatnam-521002, Krishna district, AP, India

ABSTRACT *The most advertised question these days is whether the use of a mobile causes cancer or not? As electromagnetic radiation intrigues the forms of ionizing and Non-ionizing in nature, many studies prove that exposure to ionizing radiation leads to increased risk of cancer. However, the studies resulted in no consistent evidence that non-ionizing radiation from radar, microwave ovens, and other sources causes no risk of cancer. The exposure to high levels of RF radiation can be harmful because Radio Frequency (RF) energy can heat the human body which is the principle followed by microwave ovens. Apart from cancer RF exposure has been a basis for many health threats like eye damage, skin burns, DNA changes due to thermal phenomenon of RF. If higher data rates need to be transmitted, the bandwidth required increases that obviously results in high RF exposure. As the modern mobile terminals that facilitate the applications like online gaming, web browsing, conference calling utilize much higher bandwidth for high data transactions, a communication system operating with reduced RF exposure is demanded. So, this paper aims to increase the system performance by restricting the RF exposure to its required limit without influencing the reception of desired high data rates using smart antenna deploying Constant Modulus Algorithm.*

INTRODUCTION

In the first generation of mobile communications, less efficient voice services were provided using analog transmission. But these services acquired their efficient provision only when the digital communication systems came into existence which is coined as the second generation. The idea of providing internet access on cellular phones led to the origin of 2.5 generation later being extended to the 3rd generation [2]. The transmission of much higher data rates as compared to that of data rates required for voice transmission was aimed at and it turned out to be successful in providing internet admittance dealing with multifarious data including online gaming, E-mail and video calling preferences. One of the most promising technologies that best serve the mobile terminals with high data rates is the Wideband Code Division Multiple Access (WCDMA).As the amount of data to be transmitted to the mobile increases, the effects of mobile radiation increases too. On comparison, the hectic link among uplink and downlink is identified to be the downlink as it deals with more data transactions. This is the reason for preferring the Wideband Code Division Multiple Access Frequency Division Duplex (WCDMA FDD) downlink system in order to attain minimized radiation.

WCDMA FDD DOWNLINK SYSTEM

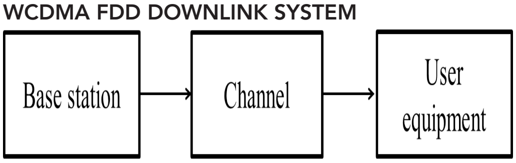

Figure 1: WCDMA FDD downlink system

As shown in the Figure 1, the WCDMA FDD downlink system comprises of a Base station, channel and User equipment. Laying efforts in the direction of lessening the radiation, changes may be made in either of the above three blocks. If one attempts to introduce a modification of signal processing in the user equipment, the improvised service would be restricted only to the latest handset users. It becomes foolish to think about making changes to channel. So, the opportunity of bringing about the manipulations of the signal in the base station is utilized such that aspiration of minimizing the impact of radiation would be realized without disturbing the desired stream of data rates [4].

System performance is the main factor whose efficiency is the aim for all the service providers, but it is getting degraded because of interference. Interference is caused due to several consequences that consist of the other mobile in the same cell, a call in progress in the neighboring cell, other base stations operating in the same frequency band or any non-cellular system which inadvertently leaks energy into the cellular frequency band. Interference affects both voice channels and control channels. Interference has been a major limiting factor for increasing capacity and often responsible for dropped calls. Therefore, a criterion that trims down the interference needs to be initiated which is the adaption criterion. The multipath diversity receiving technology improves the reception performance by combining the individual path components being received separately through the use of a rake receiver. This results in amplitude mismatch. As the multipath effect launches degradation of signal magnitude, there arises a necessity of restoring the amplitude of the signal. That is, the constant magnitude property of the radio signals should not

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be lost.

The challenge to be confronted is condensing the interference and restoring the constant magnitude property. Without focusing much at altering the base station functionality, an idea of smart antenna is implemented. This paper deals with smart antenna system using Constant Modulus Algorithm for WCDMA FDD downlink

A Smart Antenna is used in radar and wireless communication to achieve beam forming, Multiple Input Multiple Output (MIMO) communication and space time coding. Smart antenna is defined as an antenna array combined with a digital signal processor. As the name indicates antenna by itself is not smart but the digital signal processor makes it smart. Smart antenna also known as software antenna has been broadly categorized into Switched Beam antenna and Adaptive Beam antenna [1].

In case of switched beam antenna the radiation pattern is predetermined and fixed. In this context, the base station serves a user in motion by switching among the lobes in the pattern based on the position of the user. Unlike the switched beam antennas, the adaptive beam forming antennas serve the user with the same signal strength throughout the cell. Therefore, apart from maintaining the optimum signal strength, an additional advantage being facilitated by the adaptive beamforming antennas is that, the direction of interferers is replaced by nulls. This is achieved by means of adjusting the antenna weights through the use of digital signal processing algorithms. The major difference between the radiation patterns of the switched and adaptive beam antennas is illustrated in Figure 2 [5].

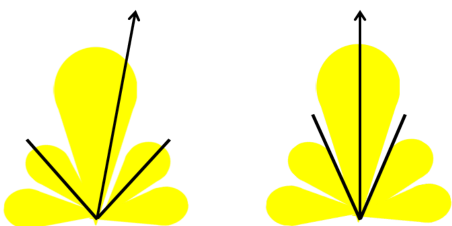

Figure 2: Switched and adaptive beam patterns.

The basic functions of smart antenna are estimation of direction of arrival and adaptive beamforming. In a beamforming system these functions are performed by an adaptive algorithm. In this paper, the Constant Modulus Algorithm (CMA) plays the role of an adaptive algorithm.

CONSTANT MODULUS ALGORITHM

The adaptive algorithms compute the antenna weights for all antenna elements so that SNIR becomes an optimum. These adaptive algorithms are designed to estimate the directions of arrival of all multipath components and it has to determine whether echo from a certain direction comes from a desired user or from an interferer. The adaptive algorithms are categorized into two types namely Continuous and Blind adaptive algorithms. The main difference between them is that the continuous adaptive algorithm makes use of a reference signal in assigning weights whereas the blind does not. The Constant Modulus Algorithm belongs to the category of the Blind ones. The CMA is chosen as a backend for the smart antenna that makes use of the constant magnitude property [6].

Due to multipath propagation, the signals undergoe reflection resulting in the radio waves reaching the receiver in two or more paths which introduces amplitude variation in the signal and destroys the constant modulus property. Thus the CMA adjusts the weight vectors of the adaptive array in a way to minimize the variation of the desired signal at the array [3]. Constant Modulus Algorithm restricts the amplitude deviation from the original signal. The weights are assigned dynamically using the equation,

$$W(k+1) = w(k) + \mu \left(1 - \left(1/|y(k)|\right) \right) y^{*}(k)\, x(k)$$

Where w(k) is weight function, μ is the step size, x(k) is the total received signal, y(k) is array output signal. The implementation of CMA utilizes the weight equation mentioned above for updating the weights for different number of antenna elements, N.

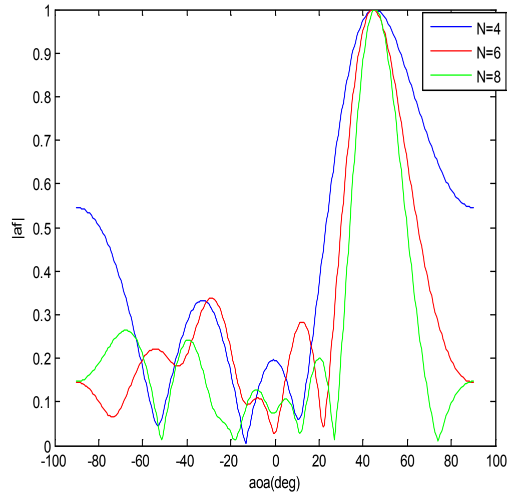

Figure 3: Beam pattern plot using Constant Modulus Algorithm for different values of N.

The Figure 3 represents the plot between Angle Of Arrival (AOA) and Array Factor (AF) for various number of antenna elements (N) and spacing between the elements (d).This multiple plot considers the values of N=4,6,8 and d=0.5λ. The half power beam width computed for N=4,6 and 8 from the plot is 38.61°,24.66°,17.99° respectively. The conclusion drawn from the plot is that, with increase in number of antenna elements, the half power beam width decreases as a result of which the directivity increases.

SIMULATION RESULTS

Therefore, to reduce the interference and adopt the constant modulus property, the smart antenna employs the CMA which is introduced in the base station transmitting section of the WCDMA downlink system. The comparison of the resulting performance of the smart system with that of the actual system is illustrated in the Figure 4.

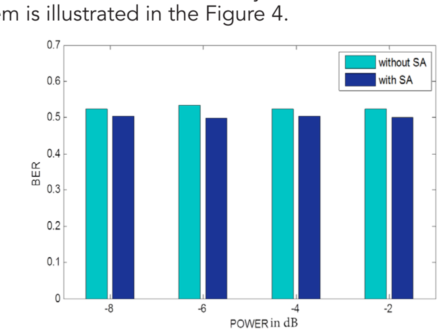

Figure 4: Performance of WCDMA downlink system with and without Smart antenna

From the Figure 4, it is observed that there is an improvement in BER of the WCDMA FDD downlink system with smart antenna as compared to that of the system performance without smart antenna. That is, without smart antenna as power increases from -8db to -2db BER decreases from 0.5246 to 0.5100 whereas with smart antenna it decreases from 0.504 to 0.47.

CONCLUSION

This paper mainly focused on the reduction of BER to increase the system performance and reduce interference thereby minimizing radiation. From Figure 4, it is evident that, there is a decrease in BER with smart antenna. Improvement in BER tends to reduce the impact of the RF exposure causing hazardous effects like eye damage, skin burns, sterility in men, DNA changes to some extent. Therefore, using smart antenna, introduction of more digital signal processing techniques in any communication system in the years to come creates a grand human favored and ecofriendly environment.

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