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A Review on Performance Improvement of Wireless System via Smart Antennas

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Abstract: ***Smart antennas have made great progress in field of communication.There are different working principles for different types of antennas in use. Each type of antenna has its own advantages and applications. It has applications in different areas wireless network system or OFDMA etc. Smart antennas enhance the capability of a mobile and cellular system. Smart antennas also help SDMA (Space division multiplexing) to increases in range. Multi path mitigation reduces the errors because of multi path fading concept of smart antennas. It also has one big advantage that is it has very high security.***

Keywords: Smart Antenna, Hybrid Approach, Performance Improvement.

1. Introduction

In smart antenna we connect an array of antenna to a digital signal processor.Due to the combination of array gain interference suppression and diversity gain we increase wireless link's capacity.Enhanced capacity translates us to data with higher rates for a predefined no. of users or also for more users for a data rate that has been given.With reflections and scattering we create multiple paths for propagation. Interference signals which are generated by microwaves are superimposed on the desired signal.The wireless communication system [6] which is opposed to wireline counterparts poses some great challenges which are:

- The limited capacity is the result of limited allocated spectrum.
- The radio propagating environment and mobility of the users give rise to the signal fading and spreading in time, space and frequency.
- Limited battery life of the mobile device poses power constraints for the wireless system using smart antennas.

Reuse of frequency causes interference which cellular wireless communications have to deal with.Since wireless communications are rapidly progressing [9], there is an investigation going on from 5 years for effective technologies which can mitigate these effects. In telecommunication system smart antenna is a port through which radio frequency is coupled from a transmitter and is transmitted everywhere and the reverse system as well. Till now no one has ever paid such great attention towards antennas but the way it has helped in transmitting the radio frequency and couple the waves and transmit them to receiver from space has influenced and has related in great use of antennas nowadays.The commercial use of smart antennas is the only solution to the mentioned wireless communications impairments.

The basic functions performed by smart antennas are direction of arrival (DOA) estimation and beam forming efficiency for transmitting.The demands for increasing the capacity of wireless network resulted in some new researches that have exploited the system of smart antennas. In cellular system the use of smart antennas has increased as it can enhance the capacity of cellular base installations. Smart antennas can be used for some significant advantages provided by it in nearly all wireless networks [2].

2. Review on Performance Improvement of Wireless System via Smart Antennas

2.1 Hybrid Smart Antenna System

Fig.2.1 shows an element adaptive smart antenna receiver system. Let us assume that the system is required to support multiple users. For a signal from any user, due to a multipath environment and the different positions of the antennas, there will be phase and amplitude differences in the signals received by the antenna elements. The output signal from any element is a particular combination of all signals and their multipath signals. These signals will first go through RF to IF blocks, and then these are converted to a digital stream by analog-to-digital converters and sent to the data bus. There are beam-forming blocks connected to the data bus. Each of these blocks needs to process digital streams obtained from the data bus, and generate a pattern to receive the signal from one of the users.

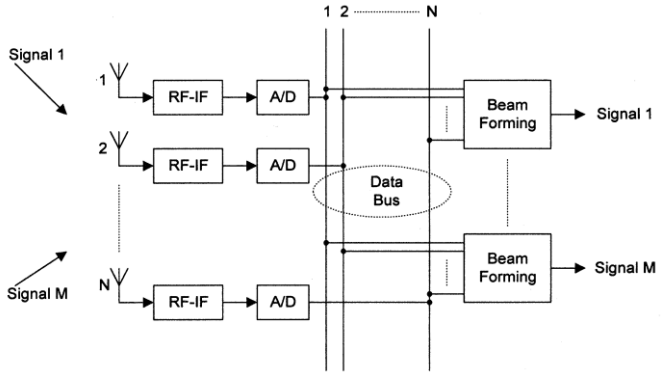

Figure 2.1: Adaptive Smart Antenna System [11]

When integrating an adaptive smart antenna simulation with a propagation model, there are many different parameters, such as array type, multipath angle spread, delay spread, cluster behavior, etc. that need to be considered [10].There are different variables whose effect is studied in this method. The first is the number of elements in the array. As expected, more elements improve the system performance, but also increase the system complexity. Eight-element arrays are widely used and are considered as a good tradeoff between performance and complexity [1].The other variables are all related to the propagation models. Some are direction of arrival (DOA), spread of multipath signal and the other is the number of multipath signals. The impact of each of these parameters on the overall system performance is high and had to be chosen carefully for increasing the overall performance of the system.

2.2 Adaptive Beamforming Antenna System

Adaptive beam forming is a commonly employed technique that enables system operation in an interference environment by adaptively modifying the system's smart antenna pattern so that nulls are generated in the angular locations of the interference sources.This approach is applicable to scenarios where multiple antenna elements are individually weighted to produce a desired directivity pattern. A typical method of forming the adaptive weights is via the Least Mean Square (LMS) algorithm, which implements a single linear constraint that maintains unit gain in the bore sight direction [8].

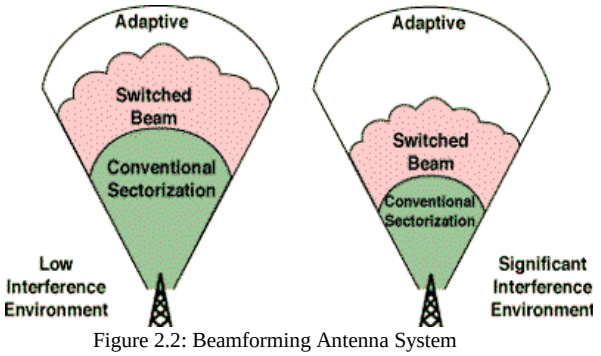

Figure 2.2: Beamforming Antenna System

The Least Mean Square (LMS) algorithm [4] is an adaptive algorithm, which uses a gradient-based method of steepest decent. This algorithm uses the estimates of the gradient vector from the available data. LMS incorporates an iterative procedure that makes successive corrections to the weight vector in the direction of the negative of the gradient vector which eventually leads to the minimum mean square error. Compared to other algorithms, LMS algorithm is relatively simple and it does not require correlation function calculation nor does it require matrix inversions [4].This technique can also be used with adaptive beam forming algorithms like traditional and improved LMS algorithm used in smart antenna. The convergence speed of LMS algorithm depends on eigen values of array correlation matrix. Traditional algorithm has slow convergence speed as step size μ is fixed. In Improved LMS as μ is variable, so the convergence rate is higher with low steady state error.

Smart antenna systems radiate particular antenna beam pattern when it communicates directionally. In smart antenna systems if a smart antenna forms side lobes and nulls or areas of medium and minimal respectively in any other direction from main lobes, it means direction of user direct toward main lobe with enhanced gain. Degree of adaptability and accuracy of lobes and nulls can be controlled by using different switched beam and adaptive smart antenna systems.

2.3 Spatial Division Multiple Accesses

Determining the capacity of Spatial Division Multiple Accesses (SDMA) systems as compared to Omnidirectional or sectorized systems is not an easy task. Theoretical approaches taken so far are usually suffering from severe simplifications which are necessary to obtain analytical results. On the other hand, Monte Carlo simulations are a very powerful means to get an insight in the performance of systems.Monte Carlo [8] stimulations are focused on the smart antenna system, so we address the issue of modeling SDMA systems for computer simulations.

The influence of traffic scenarios and channel allocation schemes on the capacity performance of SDMA systems has been explained.The simulation results emphasize that inhomogeneous traffic causes a degradation of the SDMA capacity as compared to pure SDMA and thus can enhance the efficiency of frequency usage.

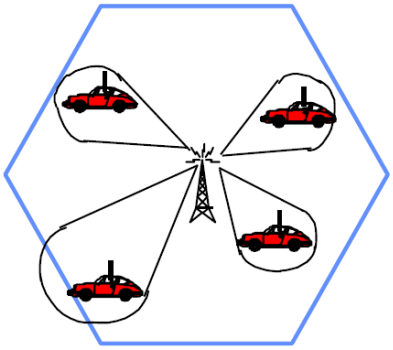

Figure 2.3: Smart Antennas with Spatial Division Multiple Accesses

2.3 Smart Antenna Systems For Mobile Ad Hoc Networks (MANETs)

A MANET is a wireless network where the communicating nodes are mobile and the network topology is continuously changing. One of the central motivations for this work comes from the observed dependence of the overall network throughput on the design of the adaptive antenna system and its underlying signal processing algorithms. In fact, a major objective of this work is to study and document the overall efficiency of the network in terms of the smart antenna pattern and the length of the training sequence used by the beam forming algorithms.

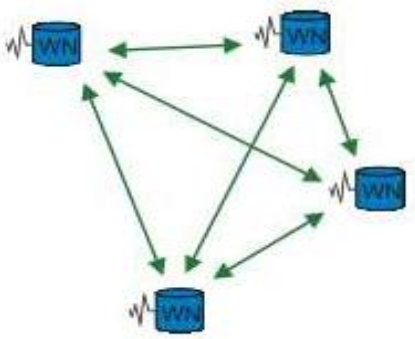

Figure 2.4: MANET Network [5]

We also have to consider sufficient detail problems dealing with the choice of direction of arrival algorithm and the performance of the adaptive beam former in the presence of antenna patterns with deeper nulls at the location of the nodes. Consequently, Spatial Division Multiple Accesses with smart antennas increases the network throughput in MANET. AS shown in fig. 2.4, in MANET networks [5], smart antennas play a very big role as mobile networks are location independent so their location keeps on changing. The smart antennas can be installed anywhere to make the connections permanent with the mobile and the network to which it belongs.

3. CONCLUSION

After studying and comparing methods by which a smart antenna can be installed for wireless networks to improve its efficiency, we have found that Smart antennas can increase the overall performance of the wireless network. There are different methods by which smart antennas can be used and which are easy to implement and tough in terms of communication and performance.

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