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Investigation of Smart Antenna: An Overview

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Abstract

In the recent years, advancement in telecommunication technologies and the increasing demand of data rate has motivated the optimized use of frequency spectrum. One technique for the efficient usage of frequency is Smart Antenna system. They provide a smart solution to the problem of communication traffic overload i.e. they increase the traffic capacity. Smart Antenna technologies will change the economics of 3G radio networks. They provide either a major data capacity gain or a significant reduction in the number of base stations required to achieve a base level of service. This paper is an overview of Smart Antenna technology, their benefits, how they work and how they can be deployed to best advantage. The research is focused on determining the feasibility of smart transmit and receive handset antennas. The goals are to show reduced power consumption, improved capacity and better link reliability. . Finally, a new wideband compact Smart antenna (SMA) is proposed. Preliminary work is presented along with numerical and experimental results for various environments such as free space, plastic casing, and the proximity of a hand.

Keywords: Antenna Arrays, Adaptive Algorithms, Beam forming, Interference, Smart antenna, Signal Nulling

Introduction

The 2G systems have been designed for both indoor and vehicular environments with an emphasis on voice communication. While great effort in current 2G wireless communication systems has been directed towards the development of modulation, coding and protocols, antenna related technology has received significantly less attention up to now. However, it has to be noted that the manner in which radio energy is distributed into and collected from space has a profound influence on the efficient use of spectrum

Background

In recent years the demand for compact and held communication devices has a significant growth included the devices size to be smaller than the palm size available in the market where the antenna size is measure factor that limits device mini There are wide variety of methods have been studied to deal with the deficiencies of the common monopole , many of these methods being based on micros trip antenna design such as SMA, a distant derivative of the monopole antenna where SMA utilizes a modify inverted low profile structure as frequently been used for aerospace application.

Problem statement

The challenge of next generation wireless communication systems comes from the fact that they will have to offer data rates in the hundreds of megabits per second. This requirement translates into the demand for wide frequency bands.

Purpose of the study

The dual purpose of a smart antenna system is to augment the signal quality of the radio-based system through more focused transmission of radio signals while enhancing capacity through increased frequency reuse.

What is a smart antenna ?

A smart antenna is defined as an array of antennas with a digital signal processing unit, that can change its pattern dynamically to adjust to noise, interference and multi paths. Smart antennas have promised to provide significant increases in system capacity and performance in wireless communication systems.

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Literature review general

This chapter provides a general overview of smart antennas and their role in Wireless communication systems. The literature survey covers topics that form the basis of the work in this thesis. In light of the thesis aims identified in the previous section, these topics are considered in the following order

1. Study and understanding the antenna theory and characteristics. 2. With a good understanding of SMA, design a new antenna to perform to the requirements listed in the criteria.3. Simulations were being done to obtain the results on the performance of the antenna with different dielectric material. 4. beam forming algorithms for smart antennas 5. Investigate on the characteristics of the new antenna and compare the results with the theory. Each of these topics is addressed in detail below. The first aim of this paper is to understand different smart antenna approaches, most importantly have a thorough understanding of a fully adaptive beam forming approach based on smart antennas.

Implementation of a smart antenna system

Smart antenna technology

Possible reasons for this may be that their forecast benefits are unobtainable, that the technology for their implementation is not mature, or that they cannot currently be implemented economically. These lead to the overall objectives of the project, namely, to assess and demonstrate the potential of smart antennas for enhancing spectrum efficiency in wireless systems. In general, the term “Smart Antenna” may be used to describe any antenna system that incorporates some degree of adaptation to the rf environment to improve performance. There are a number of alternative approaches to incorporating this adaptation

Princple of working

The smart antenna works as follows. Each antenna element "sees" each propagation path differently, enabling the collection of elements to distinguish individual paths to within a certain resolution. As a consequence, smart antenna transmitters can encode independent streams of data onto different paths or linear combinations of paths, thereby increasing the data rate, or they can encode data redundantly onto paths that fade independently to protect the receiver from catastrophic signal fades, thereby providing diversity gain. A smart antenna receiver can decode the data from a smart antenna transmitter this is the highest-performing configuration or it can simply provide array gain or diversity gain to the desired signals transmitted from conventional transmitters and suppress the interference.

Need for smart antennas

Wireless communication systems, as opposed to their wire line counterparts, pose some unique challenges. the limited allocated spectrum results in a limit on capacity the radio propagation environment and the mobility of users give rise to signal fading and spreading in time, space and frequency the limited battery life at the mobile device poses power constraints In addition, cellular wireless communication systems have to cope with interference due to frequency reuse. Research efforts investigating effective technologies to mitigate such effects have been going on for the past twenty five years, as wireless communications are experiencing rapid growth. Among these methods are multiple access schemes ,channel coding and equalization and smart antenna employment.

Multi antenna algorithms

How genetic algorithms work

Genetic algorithms are implemented as a computer simulation in which a population of abstract representations (called chromosomes or the genotype or the genome) of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem evolves toward better solutions. Traditionally, solutions are represented in binary as strings of 0s and 1s, but other encoding are also possible. The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population(based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached. A typical genetic algorithm requires two things to be defined:

1. a genetic representation of the solution domain.

2. a fitness function to evaluate the solution domain.

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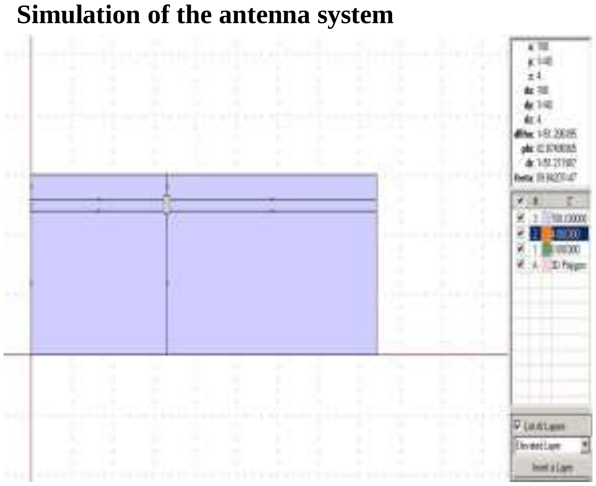
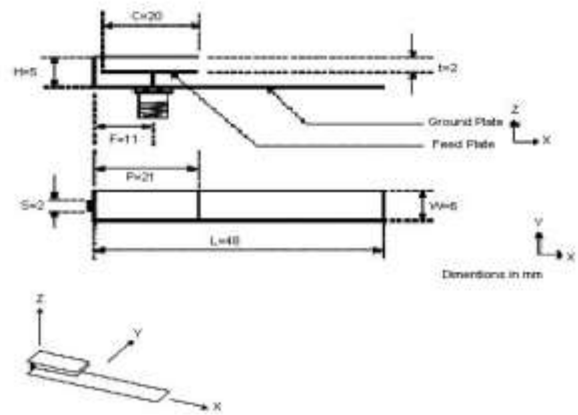
Artificial immune system (AIS)

Different aspects of the immune system (IS) have been modeled for solving different problems including anomaly detection, clustering, and function optimization. Since the interest is on the computational model, the use of biological terms is limited and simplified in the following. Anomaly Detection The obvious feature of the IS is its ability to protect an organism from harmful agents known as pathogens, such as bacteria and vira. The concept is simple: Find the pathogen, identify it as harmful, and destroy it. The cell responsible for this is thelymphocyte1. Assuming the pathogen has already been found, the distinguishing between harmful and harmless is the focus of our attention, and the destruction of harmful pathogens is replaced in an implementation by a context-appropriate response. The objective of AIS in anomaly detection is to minimize damage while maximizing usability. But being completely usable, the system would have no protection, being completely safe the system would not be usable. Once again it is a matter of balancing requirements. Self, Non-self Although the optimal classification of pathogens is either as harmful or harmless ,the IS works slightly different. Normally the lymphocytes do not know what a harmful pathogen looks like, because this information is not encoded into the organism, it only knows what itself looks like

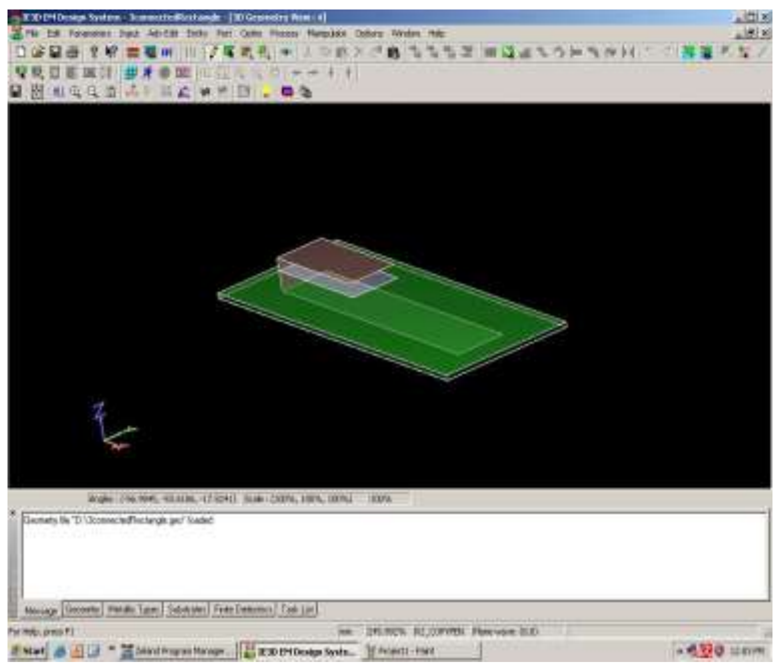
Simulation of the antenna system



Based on these results, discussions will be made on the performance of the antenna. In this chapter, the accomplished results such as return loss curves and radiation patterns will be discussed. In addition, the



directivity of the antenna and analysis of the results of the quad band SMA will be made to find out if it fulfils the basic criteria for operation in the proposed wireless communication networks or systems.



Results and discussions

The antenna to be simulated using ZELAND IE3D V 14Before getting to the analysis of the result we need understand the definition for the return loss and the far field radiation pattern

Investigation of the Smart Antenna System Performance in an Existing Wireless Communication

To investigate the strategic deployment of this smart antenna system into Wireless Communication to the optimum techno-economic advantage of mobile

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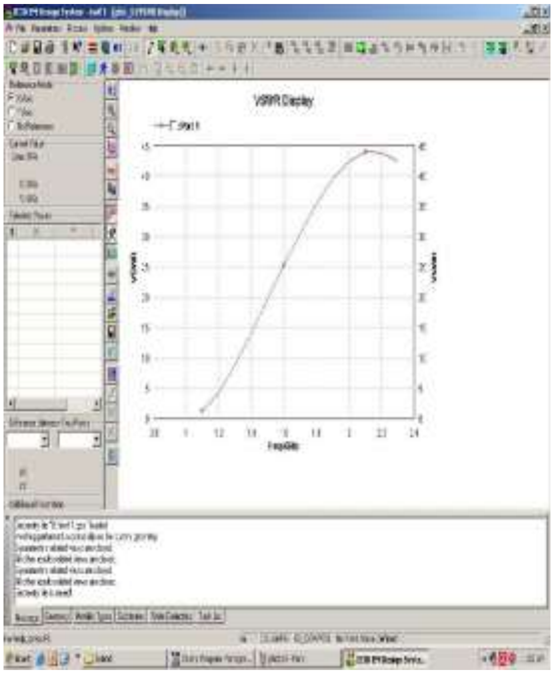
network providers, i.e. to identify the best locations for smart antennas in the radio network in the most cost-effective deployment, there is a need for a radio network planning and optimization tool.

I reveals that the 10 dB matching bandwidth of the SMA decreases as εr increases. As the value of the substrate εr rises, the antenna gives higher Q. With εr =1, the antenna provides a maximum matching bandwidth.



addition, the directivity of the antenna and analysis of the results that has fulfilled the basic criteria for operation in the proposed wireless communication network or system.

Conclusions general conclusion

In the recent years, advancement in telecommunication technologies and the increasing demand of data rate has motivated the optimized use of frequency spectrum. One technique for the efficient usage of frequency is Smart Antenna system. Smart Antennas are though developed using different algorithms, but the urge was felt for improving the technique to increase their efficiency. Therefore we humbly tried to present a new technique which tried to fulfill all the issues of smart antenna. This thesis has examined adaptive array smart antenna systems and the effects that multipath components had on their performance. The results confirmed the great interest in smart antenna systems as they proved that smart antenna systems could steer beams for reception in the direction of desired incoming signals. Furthermore, they can also place nulls in the direction of interfering signals .It was also found that signals from multiple users might as well be multipath components from the one signal arriving at different times. This is because both are uncoil-elated with the desired transmitted signal Both multipath arriving at the smart antenna at different times and at the same time were investigated. When investigating multipath arriving at the same time, it was found that only one set of weights is needed no Table discussed the fundamental limit on

Material	Permittivity	Loss Tangent	Gain vs Frequency graph analysis	Directivity vs Frequency graph analysis	Polar plot radiation pattern
Duroid	2.2	0	Decrease	Increase	Bi directional
FR4	4.4	0.02	Increase	Decrease	Uni directional
Mica	5.7	0	Increase	Increase	Uni directional
Alumina	9.4	0.01	Decrease	Increase	Bi directional
Silicon	10.4	0	Decrease	Decrease	Bi directional
GaAs	12.4	0	Increase	Decrease	Uni directional

antenna size and bandwidth. It is interesting to see where the SMA is located on the fundamental l limit curve. Compared with the other antennas shown in the figure, the SMA is the best antenna in terms of its size-bandwidth performance. An important point should be made relative to calculation of antenna size - or radius of the sphere enclosing the antenna. The sphere radius a should enclose the antenna and its image if the antenna is on a large ground plane. However, since the size of the wideband SMA ground plane is small, the structure of the antenna, including its ground plane, is contained in the sphere. Thus, the entire volume of the wideband SMA is included in the enclosing volume, whereas the conventional SMA volume excludes its average ground plane. In this chapter we have discussedthe accomplished results such as gain , smith chart radiation pattern for 3GHZ frequency band. In matter how many multipath are arriving at the same time. The major finding of the thesis was that a set of weights is not only able to steer a beam in a desired direction, but also able to steer multiple beams in multiple desired directions In theory, the inclusion of appropriate time delay filters at the output of the smart antenna system would facilitate the constructive summation of the output signal, therefore resulting in an increased signal power, meaning an increase in SNR and therefore performance is achieved .Once again, these results

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confirm why smart antennas have gained such popularity and increased attention and that they will be the future of mobile communications.

Future recommendation

We would definitely like someone to extend this project for the case of planar arrays and also doing RF end designing. This technique may also be incorporated in Radar scanning. The analysis of the adaptive array smart antenna system can be expanded in many ways. The theory of the time delay filters at the output of the smart antenna system could be investigated to prove that this can in fact be done. Only the reception of signals has been investigated, which logically leads to an investigation of transmission and then combining the two together. Perhaps other future work may look at applying smart antennas into a CDMA system. Particularly, incorporating certain types of receivers into the system may enhance the system by receiving only the strongest multipath instead of all the multipath arriving at the antenna.

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