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Smart Antennas for Mobile Communication

Prof. Manoj Mishra, Sushmita Shivalkar, Geeta Yadav, Swapnali Patil, Rinky Yadav
Electronics & Telecommunication Engineering Department, Atharva College of Engineering, Malad West, Mumbai

Abstract: *This paper present brief on wireless mobile communication using digital or adaptive antenna which is also called as smart antenna.Such type of system can place nulls in the direction of interferers via adaptive updating of weights linked to each antenna element. Thus it helps to cancel out most co-channel interference. This paper explains about the radiation pattern of the antenna and why it is highly preferred in its relative field.*
Keywords: *Adaptive antenna ,wireless antenna ,interferes ,Co-Chanel interference, antenna element*

I. Introduction

Wireless communication has large demand in recent years. With the increase in population need for mobile communication which required large coverage, high speed of transmission, better performance and radio spectrum also increases. In many communication problems like multi-path fading, path loss occurs due to physical structure as shown in figure.

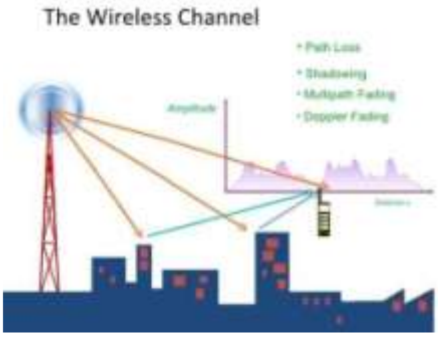

Fig 1: Effect of Multi-path fading

When signal passes through multi-path it get loss or distracted from main path i.e. it goes out of phase from desired signal due to this strength of signal get weakened at the receiver. To solve this error a system should be capable of automatically changing direction of its radiation patterns which can increase capacity and performance of wireless system. The technology which helps to improve such quantities is called as adaptive antenna or smart antenna. Capacity is primary challenge for wireless communication due to large number of subscribers which required large radio resource where as we have limited radio resources. Other major challenges includes limited battery life for user's hand held device, unfriendly transmission medium due to multipath and errors like noise, interference etc. Smart antenna includes different areas like signal processing algorithms, space time processing, array-design and network performance.

II. Types of smart antenna

System technology consist of intelligent antennas, SDMA, spatial processing, digital beam forming and other. Smart antenna categorized into two Types switched array and adaptive array. The major difference between them is transmit strategy.

A.Adaptive Array :

In this type of antenna the movement of interference & wanted user is proportional to change in beam pattern. In addition to the interference in the noise to power ratio [S/N] is done when all the signals are received & combined to increase the wanted signal. When the direction of the wanted signal will be in the form of main beam the direction of interference will be balanced.

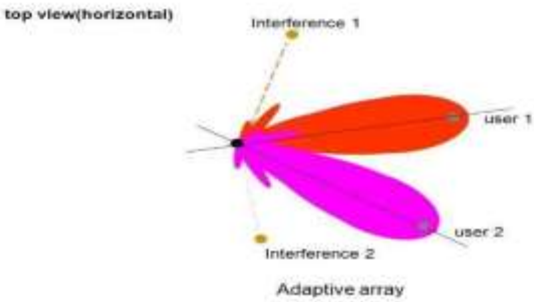

Fig 2 : Adaptive array

The antenna can control the movement of main beam to any direction as well as it will cancel out interfering signal at the same time. With the help of DOA method the direction of the beam can be determined. It can be single user beam forming or multi user beam forming.

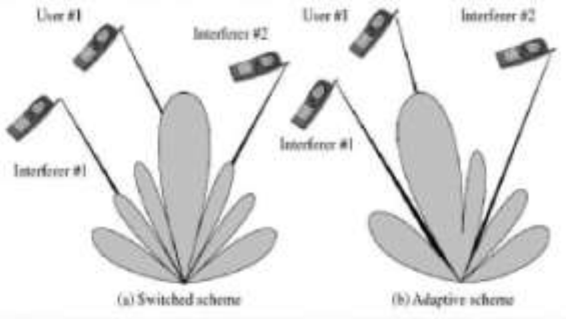

Fig 3 : Scheme of array

B.Switch Beam Array:
From the numerous amount of fixed beams, one beams will turn on or will be steered towards the wanted signal which can be done by adjustment in the phase.In short, as soon as the wanted target moves, the beam will also be steered. In order to enhance the received signal the system will select from predefined patterns. Basic switching function is used to locate switched beam.

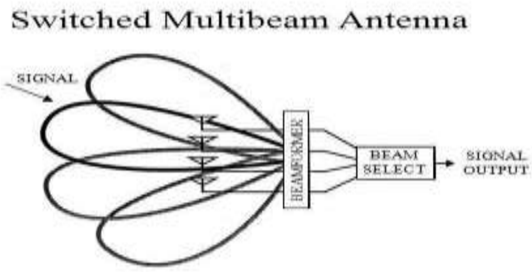

Fig 4 : Switched multibeam array

Switched array antenna can be single beam directional antenna or multi beam directional antenna. The Switched beam antenna has a switching mechanism that enables it to select and then best reception is given by right beam switch for a mobile user under consideration. The selection is depends on maximum received power for that user.

III. Goals of smart antenna

1. The aim of smart antenna is to expand the signal quality of the radio –based system using more focused transmission of radio signals.
2. We will see the potential improvement that smart antenna can provide like extension of range, multipath diversity, interference suppression, and capacity increase.
3. Other features of smart antenna includes signal gain, better range /coverage, power efficiency, interference rejection etc.

IV. Features

A.Signal Gain:

- In order to establish given level of coverage input from multiple antennas are combined so that it optimizes available power which is required.
- Base station range and coverage are increased by focusing the energy which is sent out into the cell.
- Battery life to greater extent and smaller handset size are enable by lower power.

B. ***Increased capacity:***

Combination of precise control of signal nulls quality and mitigation of interference is use for frequency reuse reduce distance and improving capacity.

C. ***Power efficiency:***

For the optimization of available processing gain in the downlink it combines input to multiple elements.

D. Spatial diversity:

- Fading and other undesirable effects of multipath propogation minimize by composite information of array.
- It is used to achieve higher SNR at the receiver side and improves signal quality.

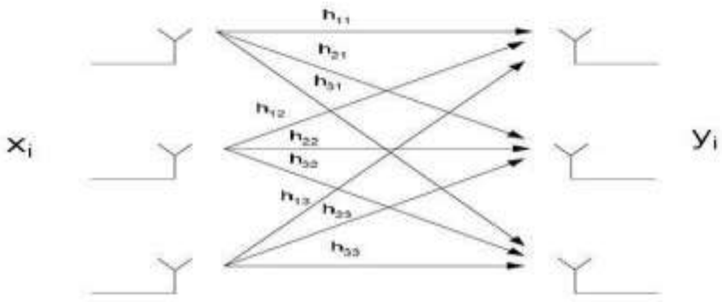

Fig 5: spatial diversity

V. Application of smart antenna

A smart antenna has capability to form transmit or receive beams used in mobile communication by placing spatial nulls in the direction of unwanted interference. Performance of mobile communication can be improved by using this capability.

A. Increased Antenna Gain:

As we know, smart antenna forms receive and transmit beams. Therefore it has higher gain as compared to conventional antenna that can be used to increase effective area or to increase receiver sensitivity. It will reduces the transmit power and radiation in network. This radiation is actually an electromagnetic radiation.

B. Decreased inter symbol interference:

Inter-symbol interference (ISI) is produces by the multipath Propogation in mobile communication .this interference is nothing but the distortion in signal which is due to the interference of one symbol with subsequent symbols . Using smart antenna which has transmit and receive beams directed to mobile of interest the amount of inter-symbol can be reduces. This will make the communication less reliable because this effect is same as the noise.

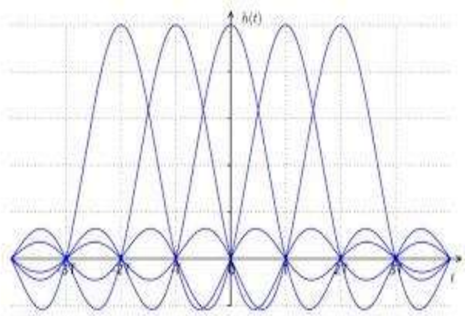

Fig 6 : Inter symbol interference

VI. Advantage of smart antenna over Conventional antenna:

1. The main contrast between both antennas is the way of dealing with the problem caused by multipath wave propogation.
2. In large distance communication, wireless signal have to pass through many barriers like tall buildings, mountains, utility wires and so on. Therefore the wavefronts will be scattered in various direction and take multipath to reach at the receiver.
3. SISO is the basic problem in conventional wi-fi communication system that is single input single output [SISO] which has one antenna at the source and other at the destination.
4. The late arrived signal at the destination may be faded, cut-out and has basic communication problem. Thus, when SISO system is used in internet connection the data arrival is late which is invalid in nature. All these problems overcome by Smart antenna.

VII. Conclusion

This paper has provided an overview which can lead to several operational benefits for a communication system to exploit different characteristics of antenna.

Smart antennas reduce fading and suppress interference which increase the capacity of existing or future mobile communication networks.For the design & simulation of any smart antenna system,knowledge of the spatially resolved mobile radio channel is essential. Depending on the maturity of underlying system, communication system will utilize different advantage offered by smart antenna. This project mainly set out to investigate the use of adaptive smart antennas in wireless system. In terms of performance and cost improvements, adaptive antennas would give significant advantages in BWAlike applications. A smart antenna is realized with conventional radiating structures and beamforming elements and it is commercially available for digital signal processing hardware. However, the use of novel materials technology can give more flexibility over the design of antennas. For example, size reduction or the geometry to be tailored more suitably to the package into which the device must be integrated. The use of novel metamaterials allowed a height reduction of about 90% in an antenna with a monopole-like pattern. In comparison with conventional smart antenna or other antenna approaches, the semismart antenna technology which has proven to be of much lower complexity and has minimal impact on the cellular system architecture. The availability of appropriate technology does not seem to be an limitation to the more widespread use of adaptive smart antennas. The principal competing technology is MIMO; for example, its use is rising rapidly in WLAN, and it is expected to be 179 Smart Antenna Technology commonly employed in other systems in the future. In summary,from the current network deployment of smart antenna scenario , the system has enormous advantages and potential for civilian cellular radio systems and could offer a viable migration path.

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