EVALUAYION OF SMART ANTEENA BEAMFORMING WITH RAB USING RBFNN

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Abstract

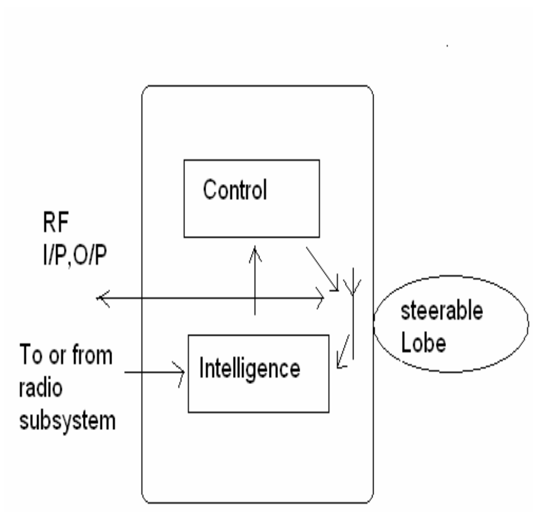
A group of antenna in which the effective radiation pattern of the array is reinforced in a desired direction and suppressed in undesired directions are called as smart antenna This is done by varying the relative phases of respective signals feeding the antenna desired direction and suppressed in undesired directions. Smart antenna are the array which incorporates smart signal processing algorithms which are usedto identify spatial signal signature such as the direction of arriving of the signal, and use it to calculate beam forming vector, The algorithm also tracks and locates the antenna beam on the mobile/target. An array antenna may be used to point a fixed radiation pattern, or to scan rapidly in azimuth or elevation. The paper explains the architectural details and evolution of smart antenna from the basic format of antenna. .

1. Introduction

In the past, wireless communication systems are deployed with fixed antenna system with fixed beam pattern. Such configuration can not meet all the requirements of modern communication environments. Smart antennas are the technology that use a fix set of antenna elements in an array. The signals from these antenna elements are combined to form a movable beam pattern that can be steered to the direction of the desired user. This characteristic makes the smart antenna and minimizes the impact of noise, interference, and other effects that degrade the signal quality. The adoption of smart antenna techniques in future wireless systems is expected to have a significant impact on the efficient use of the spectrum, the minimization of the cost of establishing new wireless networks, the optimization of service quality, and realization of transparent operation across multi technology wireless networks Smart antenna systems consist of multiple antenna elements at the transmitting and/or receiving side of the communication link, whose signals are processed adaptively in order to exploit the spatial dimension of the mobile radio channel 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. No manual placement of antennas is required.

2. . Principle of smart antena

The smart antenna electronically adapts to the environment by looking for pilot tones or beacons or by recovering certain characteristics that the transmitted signal is known to have. The base station antennas have up till now been omni directional or sectored.. The base station antennas have up till now been omni directional or sectored. This can be regarded as a "waste" of power as most of it will be radiated in other directions than toward the user and the other users will experience the power radiated in



other directions as interference The idea of smart antennas is to use base station antenna patterns that are not fixed, but adapt to the current radio conditions. This can be visualized as the antenna directing a beam toward the communication partner onlycheck your margins to see if your print area fits within the space allowed.

3. Smart antenna

In truth, antennas are not smart—antenna systems are smart. Generally collocated with a base station, a smart antenna system combines an antenna array with a digital signal-processing capability to transmit and receive in an adaptive, spatially sensitive manner. In other words, such

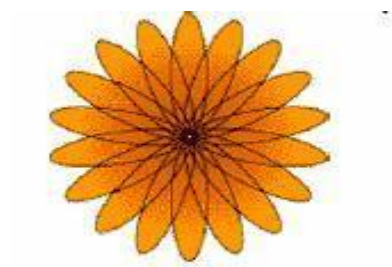
a system can automatically change the directionality of its radiation patterns in response to its signal environment. Smart antennas also known as adaptive array antennas, multiple antennas and recently MIMO that are antenna arrays with smart signal processing algorithms used to identify spatial signal signature such as the direction of arrival (DOA) of the signal, and use it to calculate beamforming vectors, to track and locate the antenna beam on the mobile/target. The antenna could optionally be any sensor. This can dramatically increase the performance characteristics of a wireless system. Smart antenna systems are customarily categorized,however, as either switched beam or adaptive array system.

4. Types of Smart Antenna Systems

- Switched beam
- Adaptive array

4.1 Switched Beam Antennas

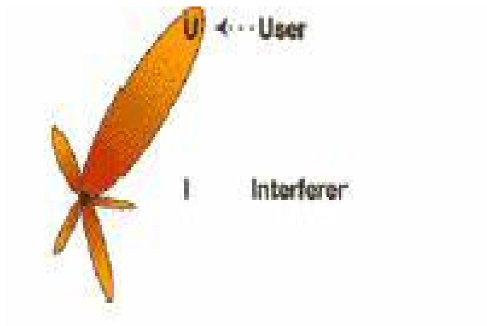
Switched beam antenna systems form multiple fixed beams with heightened sensitivity in particular directions. These antenna systems detect signal strength, choose from one of several predetermined, fixed beams, and switch from one beam to another as the mobile moves throughout the sector. Instead of shaping the directional antenna pattern with the metallic properties and physical design of a single element switched beam systems combine the outputs of multiple antennas in such a way as to form finely sectorized beams with more spatial selectivity than can be achieved with conventional, single- element approaches.



Switched Beam Antenna Pattern

4.2Adaptive Array Antennas

Adaptive antenna technology represents the most advanced smart antenna approach to date.
Using a variety of new signal-processing algorithms, the adaptive system takes advantage of its ability to effectively locate and track various types of signals to dynamically minimize interference and maximize intended signal reception. Both systems attempt to increase gain according to the location of the user; however, only the adaptive system provides optimal gain while simultaneously identifying, tracking, and minimizing interfering signals. Omni directional antennas are obviously distinguished from their intelligent counterparts by the number of employed. Switched beam and adaptive array systems, however, share many hardware characteristics and are distinguished primarily by their 18 adaptive intelligence Antenna elements can be arranged in linear, circular, or planar configurations and are most often installed at the base station, although they may also be used in mobile phones or laptops.



Adaptive Array Antennas Pattern

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5.Benefits:

5.1. Increased antenna gain- It helps increase the base station range and coverage, extends battery life, and allows for smaller and lighter handset design.

5.2.Better range/coverage-Focusing the energy sent out into the cell increases base station range and coverage. Lower power requirements also enable a greater battery life and smaller/lighter handset size.

5.3. Increased capacity- Precise control of signal nulls quality and mitigation of interference combine to frequency reuse reduce distance improving capacity. Certain adaptive technologies support the reuse of frequencies within the same cell.

5.4.Multipath rejection-It can reduce the effective delay spread of the channel, allowing higher bit rates to be supported without the use of an equalizer.

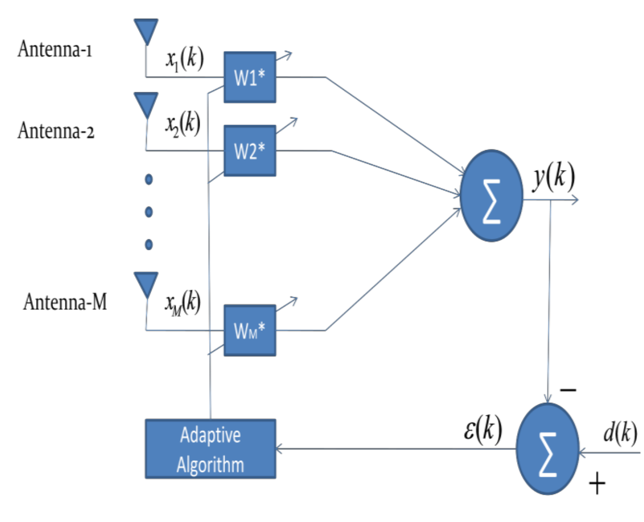
5.5. Reduced expense-Lower amplifier costs, power consumption, and higher reliability will result.

6.Beamforming

Beamforming is a general signal processing technique used to control the directionality of the reception or transmission of a signal on a transducer array. Beam forming creates the radiation pattern of the antenna array by adding the phases of the signals in the desired direction and by nulling the pattern in the unwanted direction. The phases and amplitudes are adjusted to optimize the received signal. A standard tool for analyzing the performance of a beam-former is the response for a given N-by-1 weight vector *W (k)* as function of, known as the beam response. This angular response is computed for all possible angles.

7. Adaptive Beamforming

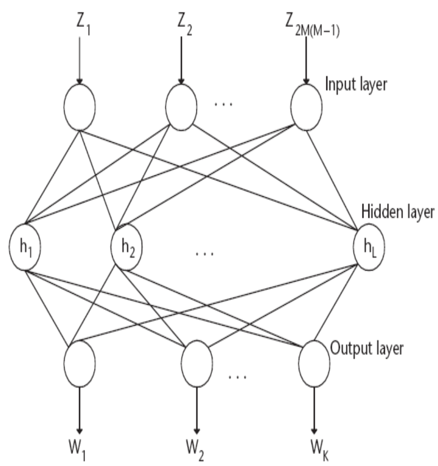
The adaptive algorithm used in the signal processing has a profound effect on the performance of a Smart Antenna system. Although the smart antenna system is sometimes called the ―Space Division Multiple Acces, it is not the antenna that is smart. The function of an antenna is to convert electrical signals into electromagnetic waves or vice versa but nothing else. The adaptive algorithm is the one that gives a smart antenna system its intelligence. Without an adaptive algorithm, the original signals can no longer be extracted. In the fixed weight beamforming approach the arrival angles does not change with time, so the optimum weight would not need to be adjusted. However, if desired arrival angles change with time, it is necessary to devise an optimization scheme that operates on-the-fly so as to keep recalculating the optimum array weight that's done by using adaptive beamforming algorithm.The adaptive algorithm in a smart antenna system serves a similar purpose as the brain in this analogy, however it is less sophisticated



Block diagram of Adaptive Beamforming

8.Radial Basis Function Neural Network (RBFNN)

RBFNN can be considered as designing neural networks as a curve fitting problem in a high-dimensional space. The mapping from the input space to the output space may be. The block diagram of an RBFNN used for beamforming is shown



The architecture considered consists of three layers—the input layer (sensory nodes), a hidden layer of high dimension, and an output layer.

Switched beamforming is a smart antenna approach in its simplest form, where multiple fixed beams in predetermined directions are used to serve the users. In this approach the base station switches between several beams that give the best performance as the mobile user moves through the cell. Most advance approach based on smart antenna techniques, known as adaptive beamforming. There are various methods of adaptive beamforming to optimize the array weights as Least Mean Square, Sample Matrix Inversion, Recursive Least Square, Constant Modulus algorithms. Adaptive beamforming has wide applications in fields such as radar, sonar, seismology, radio astronomy, and wireless communications Neural network is first trained with known input/output pattern pairs. It can be implemented offline, although a large training pattern set is required for network training. After training phase, it can be useddirectly to replace the complex system dynamics.

9.Conclusion

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.

10.Features

10.1.Signal gain-Inputs from multiple antennas are combined to optimize available power required to establish given level of coverage.

10.2 Interference rejection- Antenna pattern can be generated toward interference sources, improving the signal- to interference ratio of the received signals. On the reverse link or uplink this reduces the interference seen by base station. It also reduces the amount of interference spread in the system forward link or downlink. Such improvements in the carrier to interference ratio to increased capacity.

10.3 Spatial diversity-Composite information from the array is used to minimize fading and other undesirable effects of multipath propagation.

10.4 Power efficiency -Combines the inputs to multiple elements to optimize available processing gain in the downlink (toward users).

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