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Review ofFuzzy Logic based Adaptive Antenna Array system

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Abstract- This paper deals with a scheme to realize a smart and adaptive antenna for the Mobile base-station using Fuzzy Logic Control. This "Fuzzy Logic based Adaptive Antenna Array system" determines the required deviation of angle (DOA) to be brought in for controlling the orientation of the base station antenna beam towards the mobile unit. It can also take care of the varying and uncertain feature inherent to the mobile unit tracking' process besides incorporating the effect of the random weight fluctuation.Adaptive array antenna technology represents the most advanced smart antenna approach. 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.

Keywords- Smart antenna; Adaptive beam forming; Fuzzy logic controller

I. INTRODUCTION

IN Mobile communication environment, tracking of a mobile telephone unit is an essential task due to the unpredictable motion of the mobile unit. The uncertainty of the motion of the mobile unit can be taken care very well by Fuzzy Logic Control based scheme. Furthermore, in an Adaptive beam former system, the array weights used to track the direction of the Signal of Interest (SOl), are calculated using ideal conditions. But, the actual performance of the system is dependent upon; the implemented weights, which are erroneous due to the many types of errors caused at the various points in the system. This effect of random weight fluctuation leads to the reduced array gain. The proposed Fuzzy Logic based scheme can also incorporate the effect of this random weight fluctuation. This scheme can easily cope up with the varying and uncertain random features inherent to the mobile unit tracking process.The proposed scheme can be divided into two parts: namely the estimation of direction of arrival (DOA) of the desired signal using Adaptive method such as Pencil Beam method and the design of fuzzy logic controller. To estimate the DOA of the signal of interest, an adaptive algorithm such as Direct Data Domain method, say "Matrix Pencil method (MPM)" is applied to the transformed (or) pre-processed set of voltages obtained for the ULVA by a sum of complex exponentials. Here, the imaginary part ofthe exponents provides the DOA of various signals directly. Therefore, the application of this method results in estimated DOAs of the signals impinging on the elements of array, using a single snapshot of data. Now based on the estimated DOAs, a Fuzzy Logic Controller (FLC) system can be designed to provide a required control signal as its output.

1.1 SMART/ADAPTIVE ANTENNA-

The concept of using multiple antennas and innovative signal processing to serve cells more intelligently has existed for many years. In fact, varying degrees of relatively costly smart antenna systems have already been applied in defence systems. Until recent years, cost barriers have prevented their use in commercial systems. The advent of powerful low-cost digital signal processors (DSPs),generalpurpose processors (and ASICs), as well as innovative software-based signal-

processing techniques (algorithms) have made intelligent antennas practical for cellular communications systems.
Today, when spectrally efficient solutions are increasingly a business imperative, these systems are providing greater coverage area for each cell site, higher rejection of interference, and substantial capacity improvements.

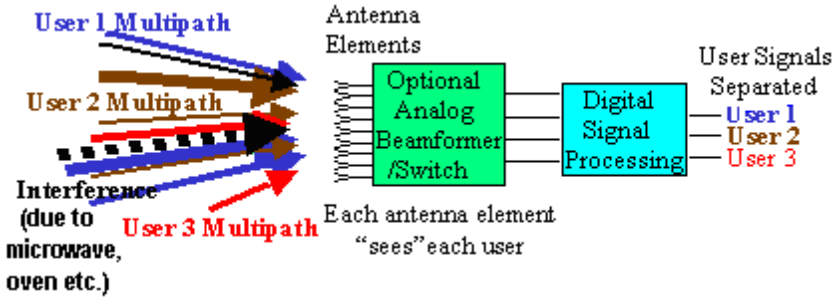


Fig-Smart Antenna System

In truth, antennas are not smart antenna systems. Generally co-located 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. Such a configuration dramatically enhances the capacity of a wireless link through a combination of diversity gain, array gain and interference suppression. Increased capacity translates to higher data rates for a given number of users or more users for a given data rate per user. In other words, such a system can automatically change the directionality of its radiation patterns in response to its signal environment. This can dramatically increase the performance characteristics (such as capacity) of a wireless system.
Multipath of propagation are created by reflections and scattering. Also, interference signals such as that produced by the microwave oven in the picture fig (1) are superimposed on the desired signals. Measurements suggest that each path is really a bundle or cluster of paths,
resulting from surface roughness or irregularities. The random gain of the bundle is called multipath fading.
Smart or adaptive antenna arrays can improve the performance of wireless communication systems. In this chapter, basic terms such as coverage and capacity are defined. An overview of strategies for achieving coverage, capacity, and other improvements is presented, and relevant literature is discussed. Multipath mitigation and direction finding applications of arrays are briefly discussed, and potential paths of evolution for future wireless systems are presented. Requirements and implementation issues for smart antennas are also considered.

Smart antennas are most often realized with either switched-beam or fully adaptive array antennas. An array consists of two or more antennas (the elements of the array) spatially arranged and electrically interconnected to produce a directional radiation pattern. In a phased array the phases of the exciting currents in each element antenna of the array are adjusted to change the pattern of the array, typically to scan a pattern maximum or null to a desired direction. Although the amplitudes of the currents can also be varied, the phase adjustment is responsible for beam steering.

A smart antenna system consists of an antenna array, associated RF hardware, and a computer controller that changes the array pattern in response to the radio frequency environment, in order to improve the performance of a communication or radar system. Switched-beam antenna systems are the simplest form of smart antenna. By selecting among several different fixed phase shifts in the array feed, several fixed antenna patterns can be formed using the same array. The appropriate pattern is selected for any given set of conditions. An adaptive array controls its own pattern dynamically, using feedback to vary the phase and/or amplitude of the exciting current at each element to optimize the received signal. Smart or adaptive antennas are being considered for use in wireless communication systems. Smart antennas can increase the coverage and capacity of a

system. In multipath channels they can increase the maximum data rate and mitigate fading due to cancellation of multipath components. Adaptive antennas can also be used for direction finding, with applications including emergency services and vehicular traffic monitoring. All these enhancements have been proposed in the literature and are discussed in this paper. In addition, possible paths of evolution, incorporating adaptive antennas into North American cellular systems, are presented and discussed. Finally, requirements for future adaptive antenna systems and implementation issues that will influence their design are outlined.

Types of Smart Antenna Systems-

Terms commonly heard today that embrace various aspects of a smart antenna system technology include intelligent antennas, phased array, SDMA, spatial processing, digital beam forming, adaptive antenna systems, and others. Smart antenna systems are customarily categorized, however, as either switched beam or adaptive array systems.

The following are distinctions between the two major categories of smart antennas regarding the choices in transmit strategy:

- Switched Beam—a finite number of fixed, predefined patterns or combining strategies (sectors)
- Adaptive Array—an infinite number of patterns (scenario-based) that are adjusted in real time

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 (like a sectorized antenna), switched beam systems combine the outputs of multiple antennas in such a way as to form finely sectorized (directional) beams with more spatial selectivity than can be achieved with conventional, single-element approaches fig.

Adaptive Array-Adaptive arrays are one of the key technologies expected to dramatically improve the performance of future wireless communications systems because they have the potential to expand coverage, increase capacity, and improve signal quality. An antenna array consists of N identical antenna elements arranged in a particular geometry, where the geometry of the array determines the amount of coverage in a given spatial region. A very widely used array type is the uniform linear array.For a given array geometry, the phases and amplitudes of the currents exciting the elements determine the gain of the array in a certain direction. In order to better estimate a signal arriving from a particular direction, the phases and amplitudes of the currents on the antenna array elements can be electronically adjusted such that received signals from this direction add in phase, and maximum gain is achieved in that direction. Due to the reciprocal nature of antennas, this approach is also applicable to focus the array beam for transmission. Figure shows a block diagram representation of an adaptive antenna array.

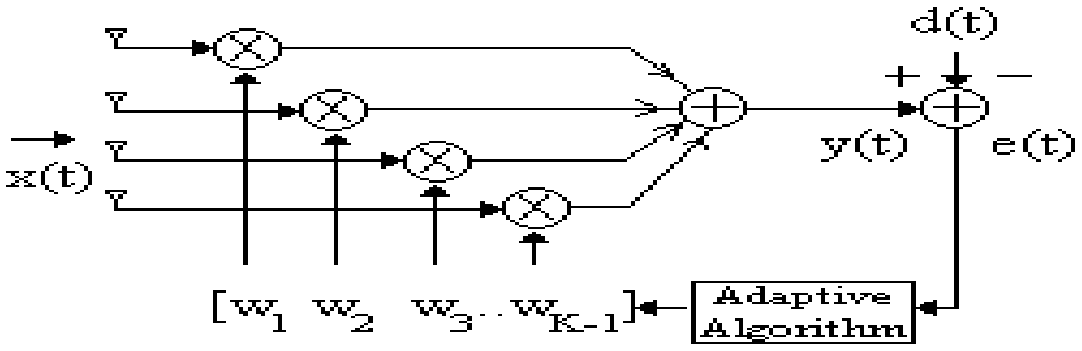
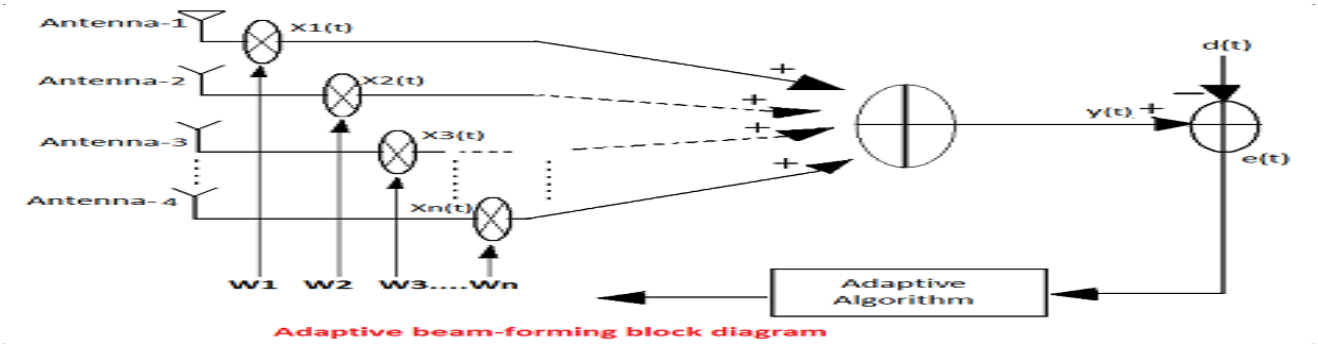


Figure- Block Diagram of Adaptive Antenna Array

To adjust the amplitude and phases of the individual currents, complex weights are placed in the signal path of each element. The weighted signals are combined and the output is fed to a control unit that operates on the individual signals and their combined output to update the weights. Weight updating is usually accomplished adaptively to satisfy an optimization criterion.

1.2 ADAPTIVE BEFORMING -

In this, we have simulated sample-by-sample adaptive beam-former using least mean square (LMS) algorithm and conjugate gradient method



Adaptive beam-forming block diagram

1.3 FUZZY LOGIC CONTROLLER-

Antenna array is a set of several antenna elements. It is mainly used to generate radiation pattern with a high directivity. In case of practical use, it is desirable to have the radiation in a certain direction. The task, in general, is to find out the antenna configuration as well as geometrical dimension and excitation distribution. Any practical use of an antenna array, it should ensure the minimum acceptable radiation pattern under certain constraints. The aim is to determine the physical layout of the antenna array that produces a radiation pattern which is nearest to the desired pattern. This process is, in general, called synthesis. We can synthesize the antenna array by reducing its side lobe level or by decreasing its null point etc. The system model of Fuzzy logic controller for Adaptive antenna system is shown in Figure. The input ofthe simulator is Estimated DOA angle, which is the desired angle parameter, to the direction the beam is to be shifted. The varying and uncertain random nature inherent to the mobile unit environment is simulated first by setting initial conditions based on the actual beam position for the Simulink system block and then the error signal is derived from the difference between the estimated DOA angle and actual (present) angle of the beam. Again this error (E) is used to beat with the previous error, to derive the change in error (del E). Then mixing ofE & del E in Mux (Multiplexer), will result in a signal that is input to the Fuzzy Logic Controller. Data are sampled at required interval of time, and are compared with the desired DOA angle ϖd(t). If difference in error (E) and change in error (del E) are not equal to zero, then controller will issue an incremental control signal change, to the Beam positioning system. The required amount of signal necessary to counteract the differences is determined by the fuzzy inference system.

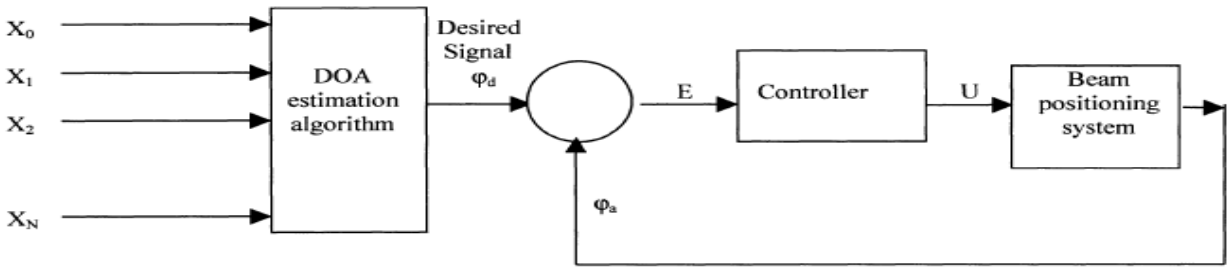


Fig:- System model of Fuzzy logic controller for Adaptive antenna system.

II. LITERATURE SURVEY

[1] "MiloudBoussahla" has researched in 2010 year, on that a new method for the synthesis of planar antenna arrays using fuzzy genetic algorithms (FGAs) by optimizing phase excitation coefficients to best meet a desired radiation pattern. We present the application of a rigorous optimization technique based on fuzzy genetic algorithms (FGAs), the optimizing algorithm is obtained by adjusting control parameters of a standard version of genetic algorithm (SGAs) using a fuzzy controller (FLC) depending on the best individual fitness and the population diversity measurements (PDM).

[2] "M. Saleem Khan " has described in 2009 year that the design model of a fuzzy logic time control discrete event DEV system under the control of multi-agents based supervisory control in local and distributed environment for industrial application of a processing plant regarding the specific product of certain quality and amount. This research work will enhance the capability of fuzzy logic time control systems in process automation with potential benefits of multi-dimensional control and supervision..

[3] "PresilaIsrat " has briefed that the integrated next-generation wireless systems (NGWS), users are always connected to the best available networks and switch between different networks based on their service needs. The objective of this paper is to develop a seamless handoff management protocol for NGWS. In this work, a fuzzy logic-based adaptive handoff (FLAH) management protocol is developed which is then integrated with an existing cross layer handoff protocol. Afterward, the handoff performance comparison of the existing protocol and our proposed protocol is carried out.

[4] In 2011." RK Jain " has put focus on The adoption of smart/adaptive 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. SAs can place nulls in the direction of interferers via adaptive updating of weights linked to each antenna element. SAs thus cancel out most of the co-channel interference resulting in better quality of reception and lower dropped calls.

[5] In feb 2013" SMITA BANERJEE " has described that The main aim of designing an adaptive antenna array is to steer the main beam in the directions of the desired signals and steering nulls in the directions of the interfering signals. The adaptive antenna system can provide a greater coverage area for each cell site, higher rejection of interference and cost-down benefit of equipment. The major area of interest in phased and adaptive arrays is their application to problems arising in radar and communication systems, where interference suppression and high reliability is required.

[6] Young-Long Chen has research on that a number of fuzzy-based power control schemes have been proposed for systems with a single rate. However, emerging CDMA cellular systems are expected to include multimedia services. This paper introduces an adaptive fuzzy-based controller to integrate power control and transmission rate management for multimedia services in CDMA cellular systems. We also compare our scheme to a multi-rate scheme called the selective power control (SPC) scheme. Results show that our scheme can achieve better performance in several measurements.

[7]Young-Long Chen, Power control and transmission rate management play vital roles in multimedia CDMA cellular systems.In this paper, we propose a novel scheme which combines fuzzy-based power control with window-based transmission rate management for use in multimedia CDMA cellular systems. We use window-based measurements to adjust transmission power by using fuzzy logic control so that each service can maintain its signal-to-interference ratio (SIR).

[8]M. Saleem Khan has put focus on that the design model of a fuzzy logic time control discrete event DEV system under the control of multi-agents based supervisory control in local and distributed environment for industrial application of a processing plant regarding the specific product of certain quality and amount This research work will enhance the capability of fuzzy logic time

control systems in process automation with potential benefits of multi-dimensional control and supervision.
[9] Maria Erman, A survey of fuzzy logic applications and principles in wireless communications is presented, with the aim of highlighting successful usage of fuzzy logic techniques in applied telecommunications and signal processing. This paper will focus firstly on discerningprevalent fuzzy logic or fuzzy-hybrid approaches in the areas of channel estimation, channel equalization and decoding, and secondly outlining what conditions and situations for which fuzzy logic techniques are most suited for these approaches. Furthermore, after insights gained from isolating fuzzy logic techniques applied to real problems.

III. METHODOLOGY

Basicallywe realize a smart and adaptive antenna for the Mobile base-station using Fuzzy Logic Control. This "Fuzzy Logic based Adaptive Antenna Array system" determines the required deviation of angle (DOA) to be brought in for controlling the orientation of the base station antenna beam towards the mobile unit.The smart antenna system estimates the direction of arrival of the signal, using techniques such as Multiple Signal Classification (MUSIC), estimation of signal parameters via rotational invariance techniques (ESPRIT) algorithms, Matrix Pencil method or one of their derivatives. Matrix Pencil is very efficient in case of real time systems and under the correlated sources. Here, first Desired DOA is given to system, and then according to it, we accepted the estimated DOA, which is calculated by adaptive array antenna system, after that error could be find out from this,then set the weightage of array system. In this system then what so ever mobile units are required for radiation pattern, fuzzy controller set the beam positioning system to those mobile units, by this system on base station send the very effective radiations to the required units.

IV. SOFTWARE TOOLS

Software is used here,That is **MATLAB**(MatrixLaboratory) R2012a.
The MATLAB® high-performance language for technical computing integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

V. RESULTS of Estimated DOA:-

Signals hasdifferent voltages in microvolts.

Table-

X0 in volts	X1 in volts	X2 in volts	X3 in volts	X4 in volts	Desired DOAangle	Estimate DOAangle
1.0	0.8	0.6	0.4	0.2	-15.4630	-15.3509
0.05	0.1	0.2	0.7	1.0	29.4630	29.2056
0.1	0.2	0.3	0.4	0.5	15.4630	15.5051
0.0	0.5	0.01	0.9	0.9	25.2020	25.2399
0.5	0.01	0.4	0.15	0.9	90.4525	90.5809
1.0	0.5	0.8	0.4	0.2	-19.3030	-19.2140

VI. FUTURE SCOPE

Here we have future for this, we can optimize the DOA with algorithms like GA (Genetic algorithm), PSO(PARTICLE SWARM OPTIMIZATION) then we will compare the values of PSO (PARTICLE

SWARM OPTIMIZATION) with (GA) Genetic algorithm. There is also a combination of Neural network of this work.

VII. CONCLUSION

Estimation of Direction of Arrival (DOA) of different signals with different voltages is carried out using only a single time snapshot data. Then, based on these estimated DOAs, a Fuzzy Logic Control based Adaptive Antenna system is proposed. Simulations demonstrated that, the integration of Fuzzy Logic in this Adaptive Antenna design takes care of the varying and uncertain feature inherent to the mobile unit tracking process and also the effectiveness of the design to incorporate the effect of random weight fluctuation.

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