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PERFORMANCE OF ADAPTIVE BEAMFORMING TECHNIQUES IN SMART ANTENNA

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ABSTRACT

The smart antenna is a new technology and has been applied to the mobile communication system such as GSM and CDMA. Advent of powerful, low-cost, digital processing components and the development of software-based techniques has made smart antenna systems a practical reality for both base station and mobile station of a cellular communications systems in the next generation. The core of smart antenna is the selection of smart algorithms in adaptive array. Using beam forming algorithms the weight of antenna arrays can be adjusted to form certain amount of adaptive beam to track corresponding users automatically and at the same time to minimize interference arising from other users by introducing nulls in their directions. Thus interferences can be suppressed and the desired signals can be extracted. This research work provides description, comparative analysis and utility of various reference signal based algorithms as well as blind adaptive algorithms. Exhaustive simulation study of beam patterns and learning characteristics have proved the efficiency of the proposed work from application point of view.

Index Terms – Antenna Arrays, Adaptive Algorithms, Beam-forming, Interference, Smart antenna, Signal Nulling

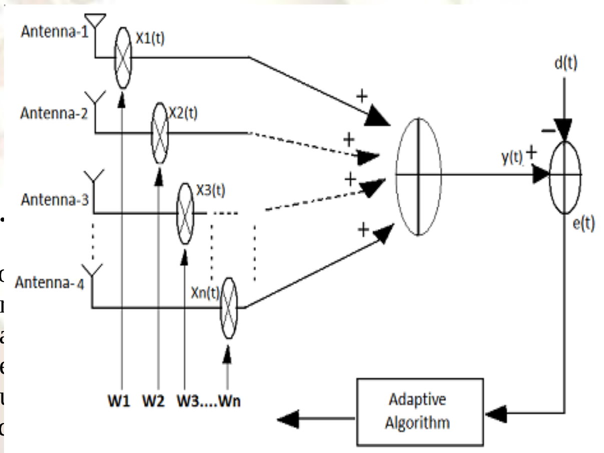
I.INTRODUCTION

Conventional base station antennas in existing operational systems are either omni directional or sectorised. There is a waste of resources since the vast majority of transmitted signal power radiates in directions other than toward the desired user. In addition, signal power radiated throught the cell area will be experienced as interference by any other user than the desired one. Concurrently the base station receives interference emanating from the individual users within the system Smart Antennas offer a relief by transmitting/receiving the power only to/from the desired directions. .Smart Antennas can be used to achieve different benefits. The most important is higher network capacity. It increase network capacity by precise control of signal nulls quality and mitigation of interference combine to frequency reuse reduce distance (or cluster size), improving capacity.

Smart antenna can be used to achieve different benefits. By providing higher network capacity, it increases revenues of network operators and gives customers less propability of blocked or dropped calls. Adaptive Beamforming is a technique in which an array of antennas is exploited to achieve maximum reception in a specified direction by estimating the signal arrival from a desired direction (in the presence of noise) while signals of the same frequency from other directions are rejected.

II.ADAPTIVE BEFORMING TECHNIQUES

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



Adaptive beam-forming block diagram

2.

estimation computed in the first process. The algorithm of LMS algorithm as shown below Define the of k,φ %k=no. of antennas,φ=angle

Algorithm for LMS

$W=1/k*[1\ e^{-j\pi\sin\varphi}\ e^{-j2\pi\sin\varphi}\ \text{-----}e^{-j(k-1)\pi\sin\varphi}]$

Noise=sinπφ+j cosπφ

X=noise

For an=1:k

n_{an} =signal_n1 * $e^{-j(k)\pi\sin\varphi}$

$x(n)=noise+n_1+n_2+x$

For an=1:k

Yan =w*x(an)

Error= d(n)-Yan

W=w+μ.error.x(an)

End

Arrayfactor=w* $e^{-j(k)\pi\sin\varphi}$

This algorithm uses a steepest decent method and computes the weight vector recursively using the equation.

$$W(n+1) = W(n) + \mu X(n)[d^*(n) - X^H(n)W(n)]$$

2.2. Conjugate Gradient Method

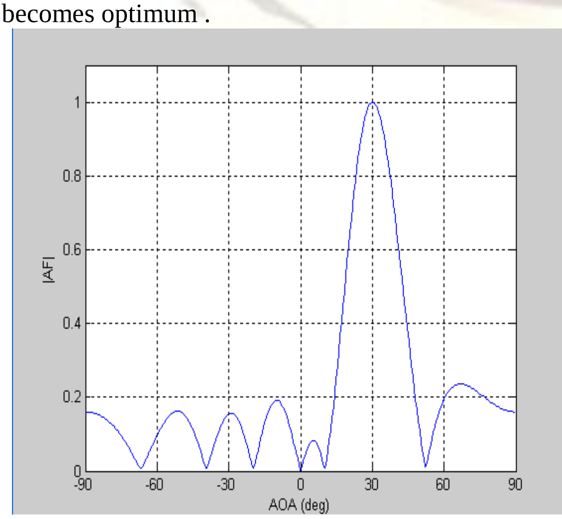
The problem with the steepest descent method has been the sensitivity of the convergence rates to the eigen value spread of the correlation matrix. Greater spreads result in slower convergences. The convergence rate can be accelerated by use of the goal is to minimize the quadratic cost function.The algorithm of CGM as show below

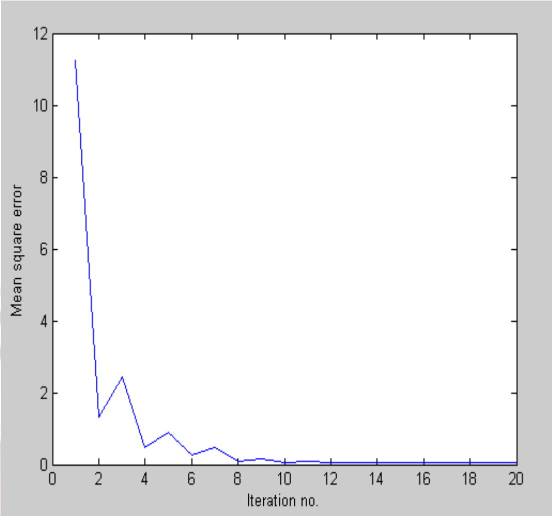
$K=0$; $x_o=0$; $r_o=b$
While($\|r_k\|^2$>tolerance)and(k<max_iter)
K++
If k=1
$P_1=r_o$
else
$\beta_k = \frac{r_{k-1} . r_{k-1}}{r_{k-2} . r_{k-2}}$ //minimize $\|p_k-r_{k-1}\|$
$p_k=r_{k-1}+\beta_k p_{k-1}$
endif
$s_k=Ap_k$
$\alpha_k=\frac{r_{k-1} . r_{k-1}}{p_k . s_k}$ //minimize $q(x_{k-1}+\alpha p_k)$
$x_k=x_{k-1}+\alpha_k p_k$
$r_k=r_{k-1}-\alpha_k s_k$
endwhile
$x=x_k$

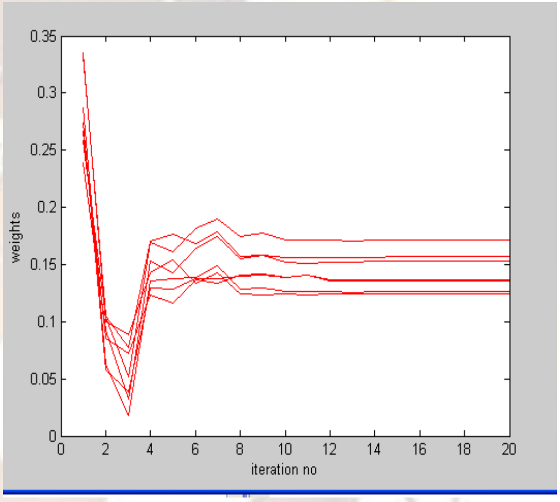
The main disadvantage of normalised LMS is its high sensitivity to measurement noise. The normalised LMS algorithm lead to amplification of the measurement noise in low order filters especially when the reference signal power is low.

III.EXPERIMENTAL RESULTS

We have used MATLAB to perform simulations of the adaptive algorithms discussed in section II. In the simulation, the smart antenna of 8-elements in LMS and 7-elements in CGM has been taken. The signal arrives at 10^o .Two interfering signals are at -35^o and 32^o. On camparing the figures of both the methods we can say that mean square error value attains its minimum value that is approximately zero in very less number of iterations . The smart antenna algorithms compute the antenna weights for all eight antenna elements so that the signal-to-noise-and-interference ratio (SINR) becomes optimum .







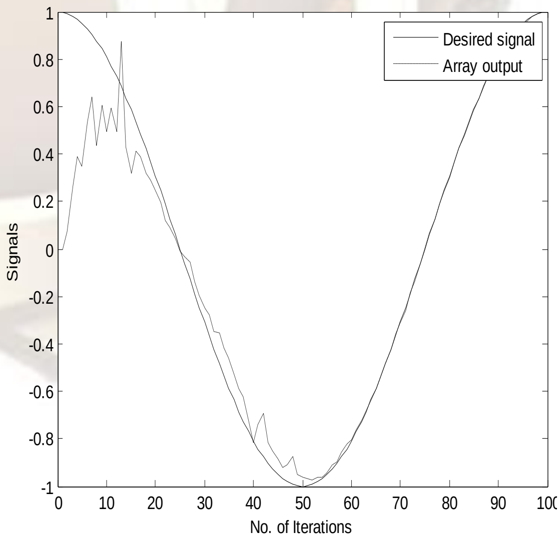
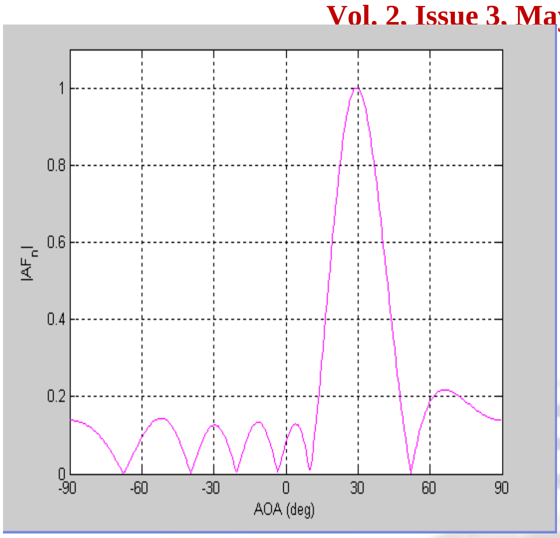


Fig.1.The simulation results set of a eight elements array using CGM algorithm for μ =0.5



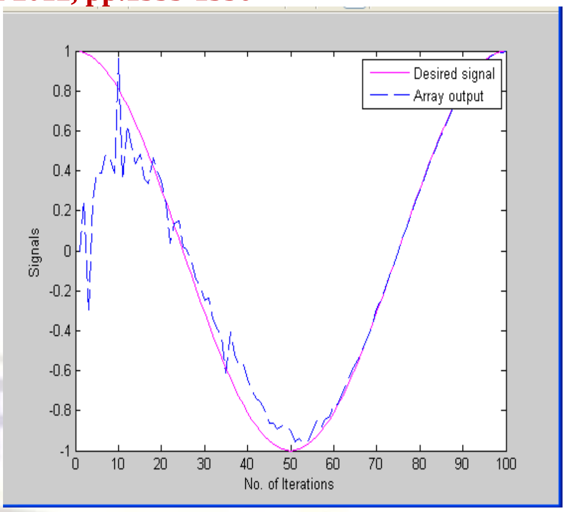
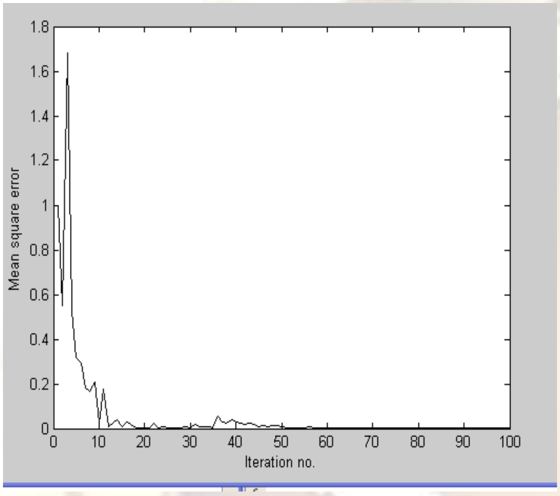
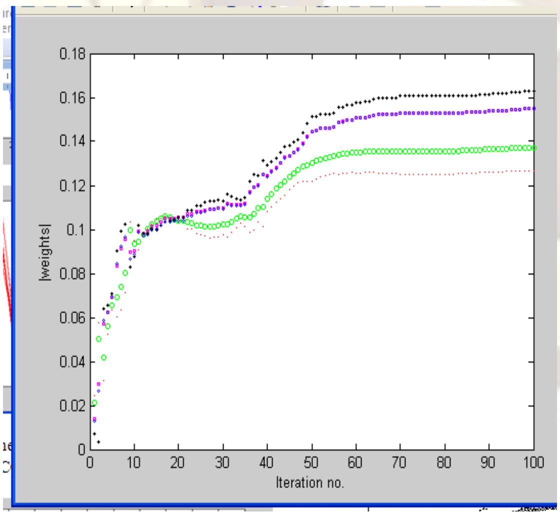


Fig.2.The simulation results set of a eight elements array using LMS algorithm for μ =0.5





IV. CONCLUSION

The LMS algorithm gives the best beam forming pattern. However, its convergence is slow and it depends mainly on the step size. If the signal characteristics are rapidly changing LMS algorithm cannot achieve satisfactory convergence. The CGM algorithm calculates the array weights by orthogonal search at every iteration. It shows good beamforming pattern and a high convergence rate. The kalman based normalised LMS algorithm shows better performance in terms of speed, accuracy and robustness.

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