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Kalman Based Lms And Rls 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 efficacies 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 thought 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 [1],[2] 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 probability of blocked or dropped calls. Adaptive Beamforming [3] 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.

In this paper is organized as follows. Kaman based Adaptive beam forming techniques in section II. The simulation results are presented in Section III. Concluding remarks are made in Section IV.

II. KAMAN BAED 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.

2.1. KALMAN BASED- LMS

The proposed kalman based LMS algotithm consists of two basic process. The first is a filter process that involves computing the output of the kalman filter, produced by a set of tag inputs and also generating an error estimation by comparing this output to a known desire signal. The second is an adaptive process involves the automatic adjustment of tap weights of the filter according to the error estimation computed in the first process. The algorithm of LMS algorithm as shown below

```
Define the of k,φS, φI %k=no. of antennas,φ=angle
vS=exp(1j*(i1)*2*pi*d*sin(øS));

vI=exp(1j*(i-1)*2*pi*d*sin(øI));

I=rand(N.k)                    %interference signal

for n = 1:k)
   x = S(n)*vS + I(n)*vI/kalman equations;
   %y = w*x.';
   y=w'*x;                          %output signal

   e = conj(S(n)) - y;              %error signal
   w=w+mu*conj(e)*x;            %weights update

end
```

End

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

The equation for kalman filter is given by

p(n+1)+qv/σ(n+1

This algorithm uses a steepest decent method [4] 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. KALMAN BASED RLS

The Kalman filter can provide unbiased estimate for system behavior under the measurement noise interference. It is the *', ZAbest estimate algorithm based on linearity minimum variance criterion. This algorithm does not require prior knowledge of the noise statistics and ensures very high rate of convergence.

The main drawback of standard kalman algorithm is its very high computational complexity. The kalman based normalized RLS algorithm overcomes the drawbacks of both the normalized RLS and the standard kalman algorithm. The kalman based RLS algorithm is less sensitive to the measurement noise. It also ensures fast convergence, high accuracy in the weight estimate, low mis adjustment, stability and decreased computational complexity. The weight update equation of the kalman based RLS is

W (n+1)=W(n)+k(n+1) ζ (n+1)/[p(n+1)+qv/σ(n+1)]

Where the error vector is given by

$$e(n) = d(n) - x^{T}(n)w(n)$$

$$\sigma_w(n+1) = \sigma_w(n)\left(1 - \frac{\frac{P(n)}{(N-1)}}{P(n)+\frac{qv}{\sigma_w(n)}}\right)$$

$$P(n) = x^{T}(n)x(n)$$

ζ(n+1)=d(n+1)-W(n)X(n+1)

The main disadvantage of kalman based RLS is its high sensitivity to measurement noise. The kalman based RLS 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 kalman based LMS and 4-elements in kalman based RLS has been taken. The signal arrives at 50^{o} .Two interfering signals are at -30^{o} and 0^{o}. 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.

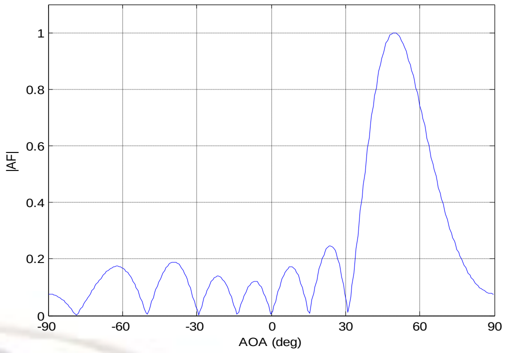

Fig.1..Normalize array factor of kalman based RLS algorithm for N=8

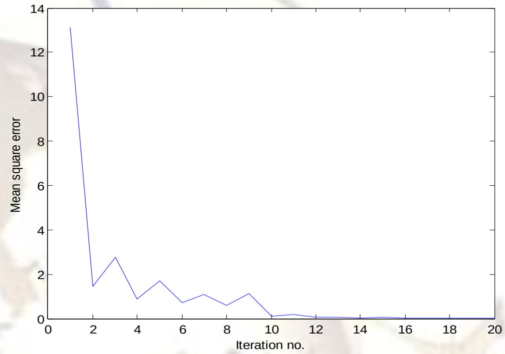

Fig.2 shows the error response for kalman based RLS algorithm for n=8 the graph drawn between samples along x-axis and mse along y-axis

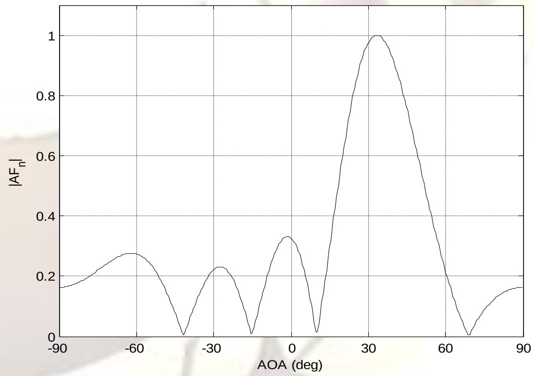

Fig.3.Normalize array factor of kalman based LMS algorithm for N=5

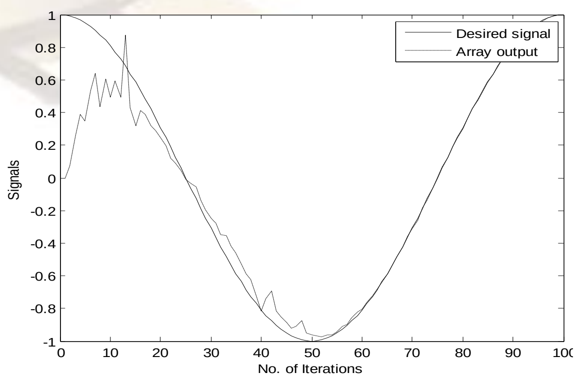

Fig.4. compare of desire signal and array output signal of kalman based LMS algorithm

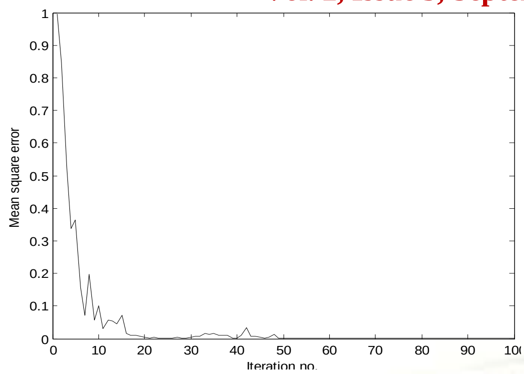

Fig.5 shows the error response for kalman based RLS algorithm for n=5 the graph drawn between samples along x-axis and mse along y-axis

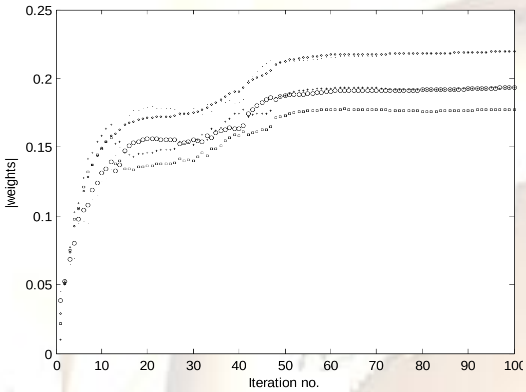

Fig.6.weighting factors of kalman based LMS algorithm for μ =0.5

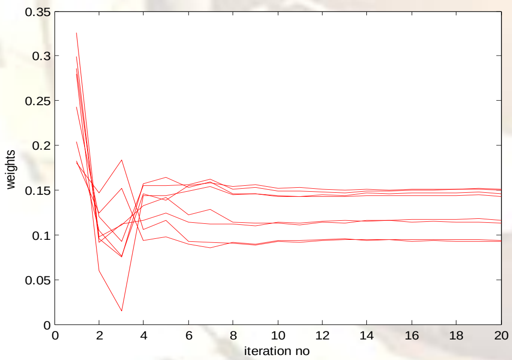

Fig.7.weighting factors of kalman based RLS algorithm for μ =0.5

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 kalman based RLS algorithm calculates the array weights by orthogonal search at every iteration. It shows good beamforming pattern and a high convergence rate. The kalman based normalized LMS algorithm shows better performance in terms of speed, accuracy and robustness.

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