RESEARCH ARTICLE OPEN ACCESS

PERFORMANCE ENHANCEMENT FOR SMART ANTENNA USING ARLS TECHNIQUE

Rohit Bansal*, Vishal Garg**, Manpreet Kaur***

[1,2,3](Department of Electronics & Communication Engineering)

Swami Vivekanand Institute of Engineering & Technology, Banur (INDIA)

--************************----------------------------------

Abstract:

Matrix decomposition refers to the transformation of a matrix into a canonical form. The purposes of matrix decomposition are analytic simplicity and computational convenience. As a result of the decomposition of the given matrix, the resulting matrices have lower-rank canonical form and this helps revealing the inherent characteristic and structure of the matrices and help interpreting their meaning. Adaptive Recursive Least mean squares (ARLMS) algorithms are a class of adaptive filter used to mimic a desired filter by finding the filter coefficients that relate to producing the least mean squares of the error signal of the RLS algorithm to improve the overall beam forming of the smart antenna array. The system has also been simulated using MATLAB.

Keywords **—ARLMS, QR, Smart Antenna, ALS, Matrix Decomposition, RLS.**

--************************----------------------------------

I. INTRODUCTION

The application of wireless strategies is the newest movement in communication knowledge, and there is a constant request for density or miniaturization of wireless electronic devices, as well as an upsurge in speed and data rate for these devices. In this respect, MIMO antenna schemes are being careful for better show, and they present antenna engineers with numerous project challenges. Multi-Input Multi-Output (MIMO) antenna schemes have complicated considerable attention as an actual method of successful reliability and cumulative the channel volume in wireless mobile infrastructures. MIMO antennas can allow delivering high quickness and high quality broadcast connecting great quantity of data transmission in rich multipath settings. MIMO antennas for wireless receiver requests necessitate decidedly well-organized antenna strategy that delivers enough spatial de-correlation, which experiments for manipulative in a small receiver device. In instruction to achieve a high isolation, good diversity and multiplexing performance are compulsory.

Figure 1: Multi-Input Multi-Output (MIMO) Antenna

The RLS algorithm would require floating point precision, or very long fixed point word lengths, due to its numerical ill-conditioning. In addition to

Multiply/Add standard RLS implementation also requires divide operations. Hence the consequences of overflow and underflow can cause serious problems such as Divide-by-zero errors, etc. Hence for FPGA fixed point implementation, RLS must be carefully implemented. This motivates the QR-RLS algorithm method which is the most numerically robust method of RLS implementation and aims to keep the dynamic range of values low

II. RELATED WORK

Popularly referred as smart antenna, adaptive beam forming is one of antenna arrays application in mobile communication. With the ability to adaptively directing the beam in specific directions, it is known to be an effective technique in cancelling co-channel interference. Some of the invaluable references that thoroughly outlined all the methods and algorithms include [1 - 4]

J. Litva and K. Y. Lo in Chapter 3 of [1] explained in detail, criterion includes Minimum Mean-Square Error, Maximum Signal-to-Interference Ratio and Minimum Variance was discussed in the book. The choice of criteria is not critically important since they are closely related to each other. The more important part is the adaptive algorithms, which will determine the speed of convergence and hardware complexity required.

An earlier literature by B. D. V. Veen and K. M. Buckley [2] introduced beam forming as a versatile form of spatial filtering. Started with the basic concept, associated the explanation with FIR filtering. Beam former was classified into data independent and statistically optimum beam former. Independent of the received data, the first class of beam former chose a fixed antenna arrays weights.

Krzysztofik W.J. and Fafara M. in [5] present the comparison study of a few direction-of-arrival estimation methods. They have shown from computer simulation results, MUSIC algorithm won the best angle resolution method followed by Min-Norm method. Followed by Capon's algorithm and finally Barlett's algorithm. They also concluded that increasing the sampling number will improve the angle of resolution of all DOA methods, except Barlett's. Finally, the most sensitive method on SNR level is Capon's algorithm.

Dr K.R.Santha, Bharani Chakravarthy Chava,K.Bragadishwaran and K.Chandruin [6] Field-programmable gate arrays (FPGA) are drawing increasing interest because of its performance, power consumption and configurability. They execute wide range of parallelizable algorithms which changes in accordance to variations in wireless channel statistics are utilized in smart antenna array embedded systems.

III. SYSTEM MODEL

The simulation results will be obtained for the QR factorization and QRD-RLS algorithm both for the floating-point as well as the fixed-point models. An overall architecture will be created in MATLAB for four sensor elements and is then simulated. Consider a Uniform Linear Array (ULA) with N isotropic elements, which forms the integral part of the adaptive beamforming system as shown in the Fig.2 below:

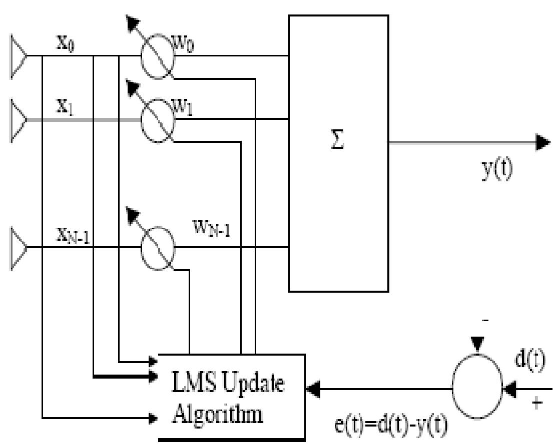

Fig. 2. LMS Adaptive Network

The output of the antenna array x (t) is given by:

$$x(t) = s(t)a(\theta_{\circ}) + \sum_{i=1}^{N_u} u_i(t)a(\theta_i) + n(t)$$
(1)

(*t*) Denotes the desired signal arriving at angle $\theta_0$and *ui* (*t*) denotes interfering signals arriving at angle of incidences r$_e$spectively. *a* (θ_0) and *a* (θ_i) represent the steering vectors for the desired signal and interfering signals respectively. Therefore it is required to construct the desired signal from the received signal amid the interfering signal and additional noise *n* (*t*) [7].

IV. PROPOSED ARLS ALGORITHM

Adaptive signal processing algorithms such as least mean squares (LMSs), normalized LMSs (NLMSs), and recursive least squares (RLSs) have been used in numerous wireless applications such as equalization, beamforming, and adaptive filtering With the advent of wideband 3G wireless systems, adaptive weight calculation algorithms are also being considered for new applications, such as polynomial-based digital predistortion and multi-in/multi-out (MIMO) antenna solutions. MIMO(Multiple-InputMultiple- Output)systems use multiple antennasatboththetransmitterandthereceiver.These applications generally involve solving for an over-specified set of equations, as shown below where m > N.

Among the different algorithms, the recursive least squares algorithm is generally preferred for its fast convergence property. The least squares approach attempts to find the set of coefficients c_n that minimizes the sum of squares of the errors, that is., {min Σ e (m) ^{2}}. Representing the above set of equations in the matrix form, we have:

XC =y+e ……………………………………. (2)

Where X is a matrix (m x n, with m>N) of noisy observations, y is a known training sequence, and c is the coefficient vector to be computed such that the error vector e is minimized. .

V. SIMULATION RESULTS

In this section, adaptive beam former has been implemented using MATLAB. The performance of the proposed adaptive beam former has been evaluated and compared with an earlier work.In Proposed algorithm space between the elements play an important role in beam forming and it is taken as 0.9 lemda. Where number of array element -20, 0 and 20, desired user is arriving at 0 degree, interference angle of -20 degree by keeping spacing distance “d” constant and forgetting factor 0.95.

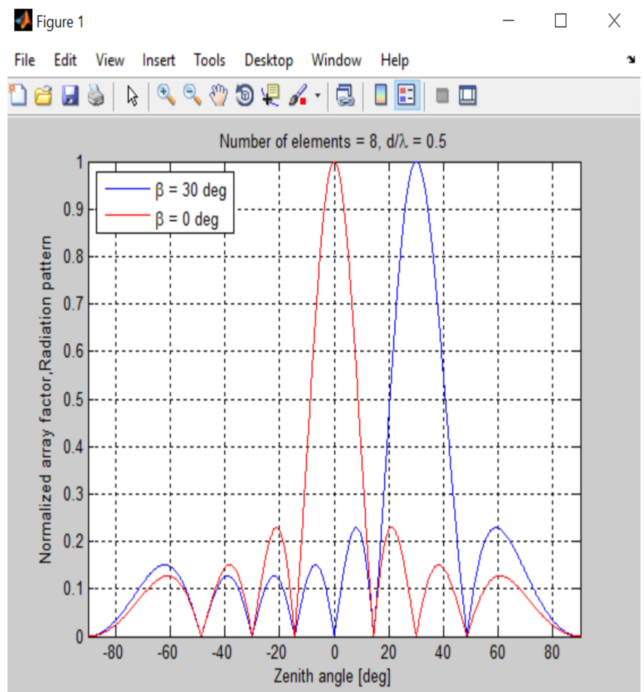

Fig 3: Normalization array for radiation pattern

In figure 2,space between the array element play an important role in beam forming technique and it is taken as 0 to -70 radiation pattern Where number of array element 0, 20 and 40, desired user is arriving at 0 degree, interference angle of -30 degree by keeping spacing distance “d” constant and forgetting factor 0.95.

ISSN : 2581-7175

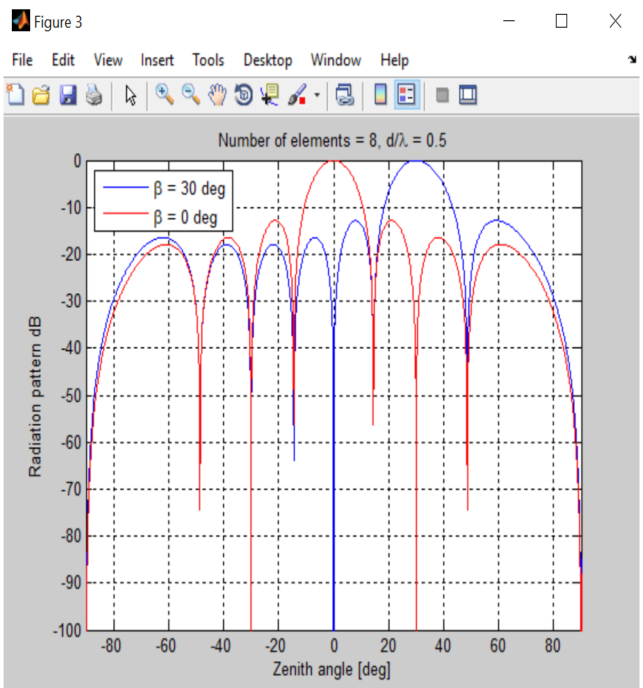

Fig 4: Radiation pattern in dB at beta =0 and 30 degree.

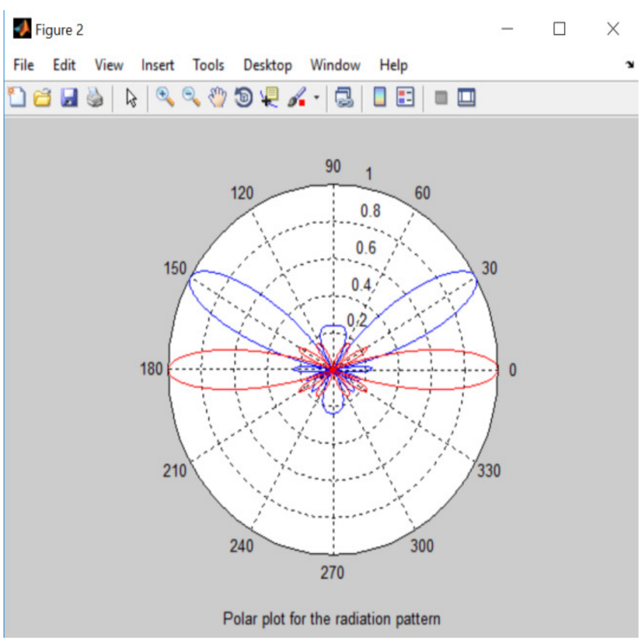

Fig 5: Polar plot for Eand H plane

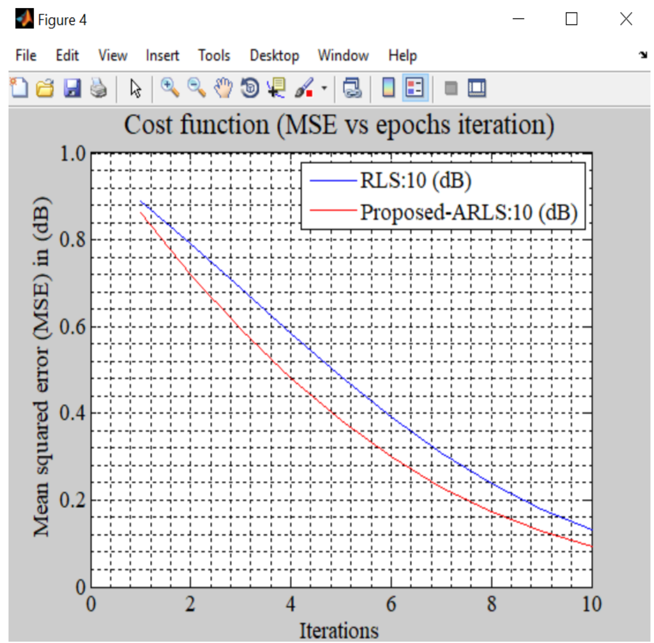

Fig 6: Mean square error plot for proposed ARLS approach at 10 dB variance and existing approach RLS

Fig 6 shows the desired signal corrupted with the mean square error. Comparing Fig 3 and 4, it has been concluded that the interfering signal has resulted in an undesired peak in the spectrum, which should be removed by using adaptive beam former. Fig 4 shows the output spectrum of broadside array antenna consisting of four antennas without applying beamforming.

Iterations	Our Work(ARLS) MSE	Base(RLS) MSE
2	0.75	0.8
4	0.53	0.6
6	0.31	0.42
8	0.22	0.28
10	0.16	0.189

From Table 1, it can be concluded that our adaptive beam former also performs better in terms of resource utilization.

VI. CONCLUSION AND FUTURE SCOPE

Research on applications of smart antenna arrays have been taking advantage of the fact that users collocated in frequency domain are typically separated in spatial domain, the beam former is used to direct the antenna beams toward the desired user while cancelling signal from other users. The sensitivity of gradient step size μ of ARLMS algorithm can be reduced by using gain matrix of RLS algorithm. It shows good beam forming patron and high convergence rate. Thus, array element increasing from 9 to 10 the beam width become narrow and the number of side lobes goes on increasing. We can term adaptive antennas as the future of wireless communication.Future work can be focused on finding some another suitable algorithms which can lead to fasts convergence and less resource utilization.

REFERENCES

[1] S. Applebaum, "Adaptive arrays," Technical Report SPL TR-66-001, Syracuse Univ. Rec., Corp. Report, 1965
[2] J. Litva, T. K. Lo, "Digital Beamforming in Wireless Communications," Artech House, Norwood, 1996
[3] A. J. Goldsmith, S. G. Chua, " Variable-Rate Variable-Power MQAM for Fading Channels," IEEE Trans. Commun., vol. 45, pp. 1218-1230, October 1997
[4] A. Goldsmith and P. Varaiya, "Capacity of fading channels with channel side information," IEEE Trans. Inform. Theory, vol. 43, pp. 1986-1992, 1997
[5] Y. Ko and C. Tepedelenlioglu, "Comparison of Adaptive Beamforming and Adaptive OSTBC with Outdated Channel Feedback," IEEE Conference Record of the Thirty-Eighth Asilomar Conference on Signals, Systems and Computers, vol. 1, 7-10, pp.1232 – 1236, Nov. 2004
[6] Y. H. Pan, K. Lataeif, Z. Cao,"Dynamic Spatial Subchannel Allocation with Adaptive Beamforming for MIMO/OFDM Systems,", IEEE Trans. Wireless Commun., vol. 3, pp. 2097-2107, Nov. 2004
[7] B.D. Van, K. M. Buckley, "Beamforming: A Versatile Approach to Spatial Filtering,", IEEE ASP Magazine, pp. 4- 24, April 1988
[8] L. C. Godara, "Applications of Antenna Arrays to Mobile Communications, PartI: Performance Improvement, Feasibility, and System Considerations," in Proc. IEEE , vol. 85, pp. 1031-1060, July 1997
[9] L. C. Godara, "Applications of Antenna Arrays to Mobile Communications, PartII: Beam-Forming and Direction-of-Arrival Considerations," in Proc. IEEE, vol. 85, pp. 1195-1245, August 1997
[10] W.J. Krzysztofik, M. Fafara, "Comparison& Examination the Mtehods of Direction-of-Arrival Estimation," IEEE Antennas & Propagation Society International Symposium, vol. 4a, pp. 154-157, 3-8 July 2005
[11] S.ilKwak, Kihun Chang, and Y. J. Yoon, 2005, Ultra-wide band Spiral Shaped Small Antenna for the Biomedical Telemetry, Asia Pacific Microwave Conference, 2005, Vol 1.
[12] C. M. Lee, Tzong-CheeYo, and Ching-HsingLuo, 2006, Compact Broadband Stacked Implantable Antenna for Biotelemetry with Medical Devices, IEEE Annual Wireless andMicrowave Technology Conference, pp. 1-5.