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BEAM FORMING OF ADAPTIVE SMART ANTENNA ARRAYS USING COMBINED ALGORITHM

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Keywords: *SMI-RLS, SMI-LMS,LMS-RLS*

ABSTRACT
Beam forming is done for antenna arrays using combined algorithms like SMI with LMS and its variants. Then a comparative study of beam forming techniques using combined algorithms like sample matrix inversion with least mean square (SMI-LMS), simple matrix inversion with recursive least square (SMI-RLS) and least mean square with recursive least square (LMS-RLS) algorithm is presented. The performances of the algorithms are compared on the basis of side lobe level, null depth and square error estimation.

INTRODUCTION
Beamforming refers to the technique that aims at improving captured sound quality by exploiting the diversity in the received signals of the microphone array depending on the location of the source and the interference. Adaptive beamforming systems are those that employ adaptive array processing. It is the method of creation of nulls towards interference and strong beams towards preferred user. Ultrasound beamforming system has moved from the analog era to the digital era due to the progression of digital circuit design. The computational flexibility of digital system allows the dynamic receive focusing to be performed in order to achieve better image quality. Antenna design gets several advantages because of beamforming. Firstly, space division multiple accesses are achieved since a beam former can steer its look direction towards a certain signal. Other signals from different directions can reuse the same carrier frequency. To estimate the concert analysis of different algorithms like Least Mean Square and Multiple Signal Classification smart antennas are utilize Smart antenna system consists of antenna array with digital signal-processing capability. Spatial filtering takes place in digital signal processor [1]. Smart antenna enhances the data capacity in wireless networks by focusing the radiation only in particular (desired) direction and adjusts according to the traffic or signal environment and subsequently decreases multipath and co-channel interference [2]. The direction of arrival depends on phase difference between the array elements. So, it is possible to focus the main beam in particular intended direction by adjusting the phase difference [3]. Mainly the Smart antenna system is used to reduce the co-channel interference, increase the capacity and range and decrease the transmitted power and handoffs [4] [5]. Adilson *et al.* [6] presented a low cost hardware implementation of smart antennas based on FPGA which uses two different cards namely the front end card and FPGA card .Wang *et al* [7] proposed complex-valued genetic algorithm and used for function optimization. Mathur *et al.* [8] proposed decision directed approach for blind adaptation of smart antenna system using complex neural estimation of parameters for beamforming. In order to address these problems, kadri *et al.* [9] proposed new technique for the synthesis of Phase only planar antenna arrays using fuzzy genetic algorithms where the control parameters are tuned according to the environment changes. Jain *et al.* [10] made brief description of Smart Antenna which is used to reduce severe effects of wireless communication via multi-path fading, inter-symbol interference and enhance the capacity. Liaqat Ali *et al.* [11] analyzed the performance of Adaptive beam forming algorithms for limiting the jamming signals.

Beam forming algorithms
Figure 1, Figure 2 and Figure 3 shows flow chart for combined algorithms like SMI-RLS, SMI-LMS, and LMS-RLS respectively .First the weight of SMI is estimated for the cost function and then the weight of RLS algorithm is initialized by the weight of SMI algorithm. Similar procedure is followed for SMI-RLS, SMI-LMS, and LMS-RLS algorithm. All the algorithms are applied for one dimensional and two dimensional weights updating for linear and
planar arrays respectively

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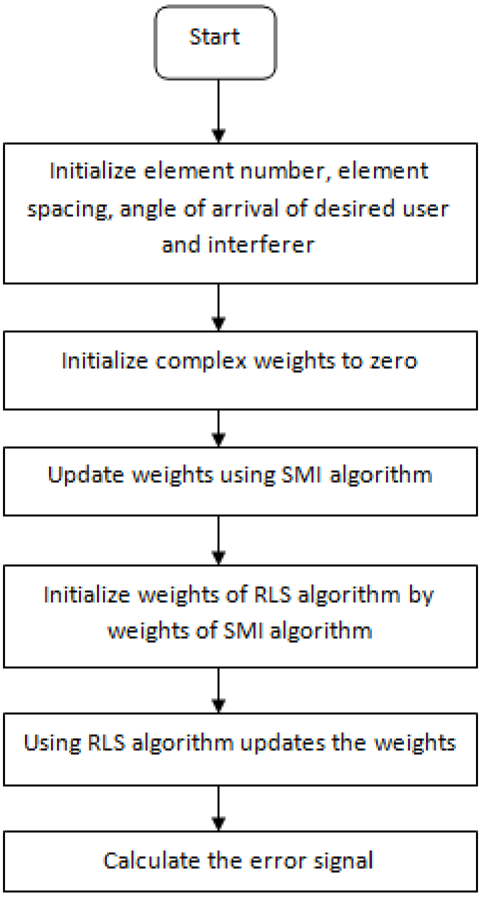

Fig 1: Flow chart of combined SMI-RLS algorithm used for beamforming

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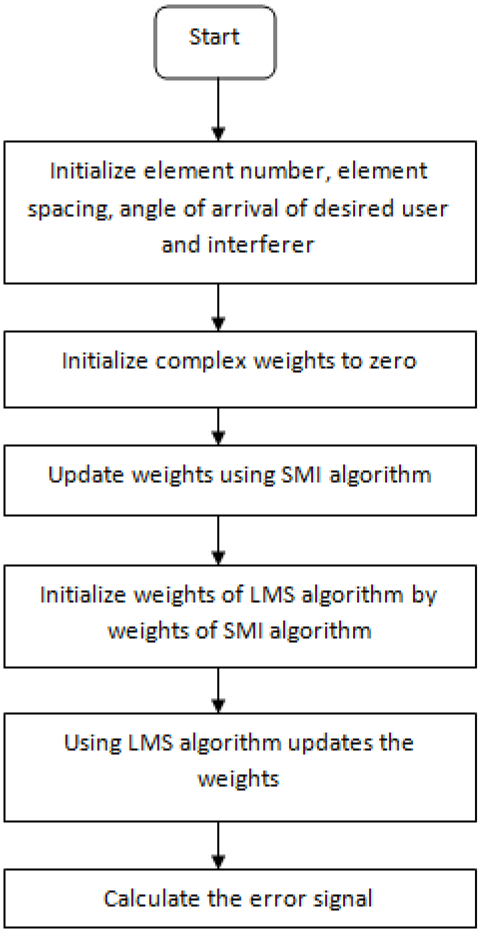

Fig 2: Flow chart of combined SMI-LMS algorithm used for beamforming

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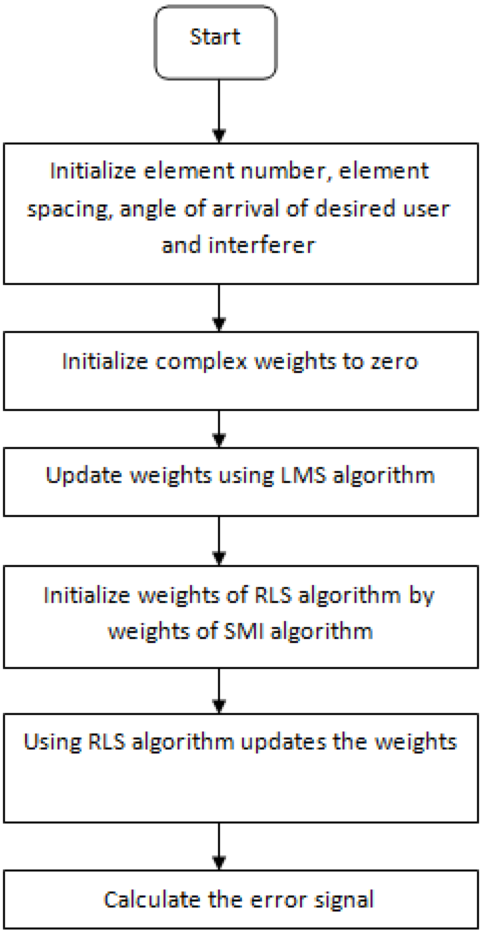

Fig 3:Flow chart of combined LMS-RLS algorithm used for beamforming

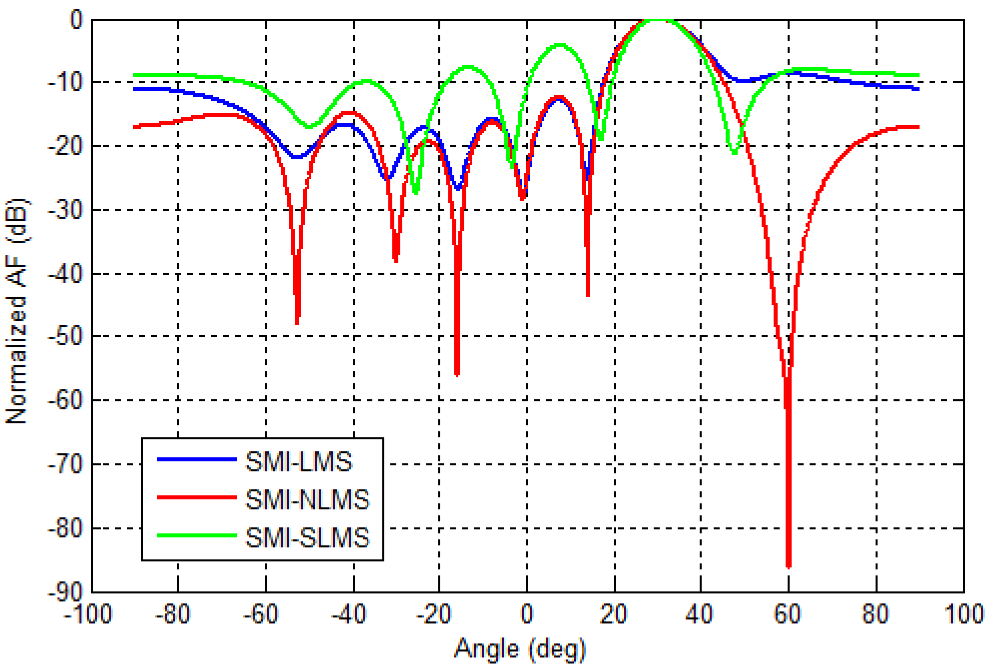

Fig 4: Simulation result for linear array using combined algorithms where μ = 0.2

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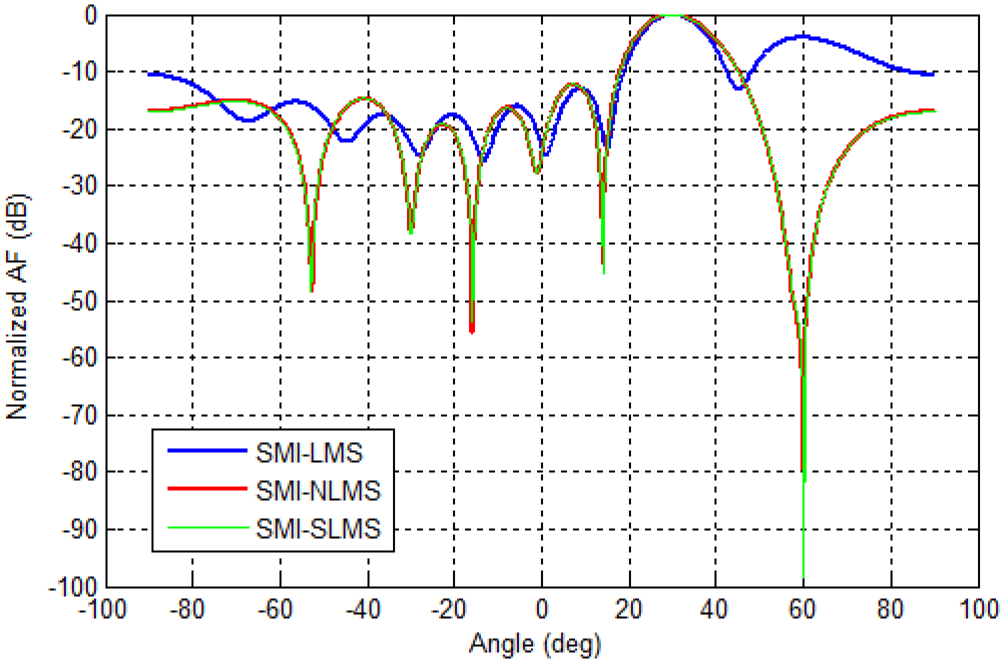

Fig 6: Simulation result for linear array using combined algorithms where μ = 0.1

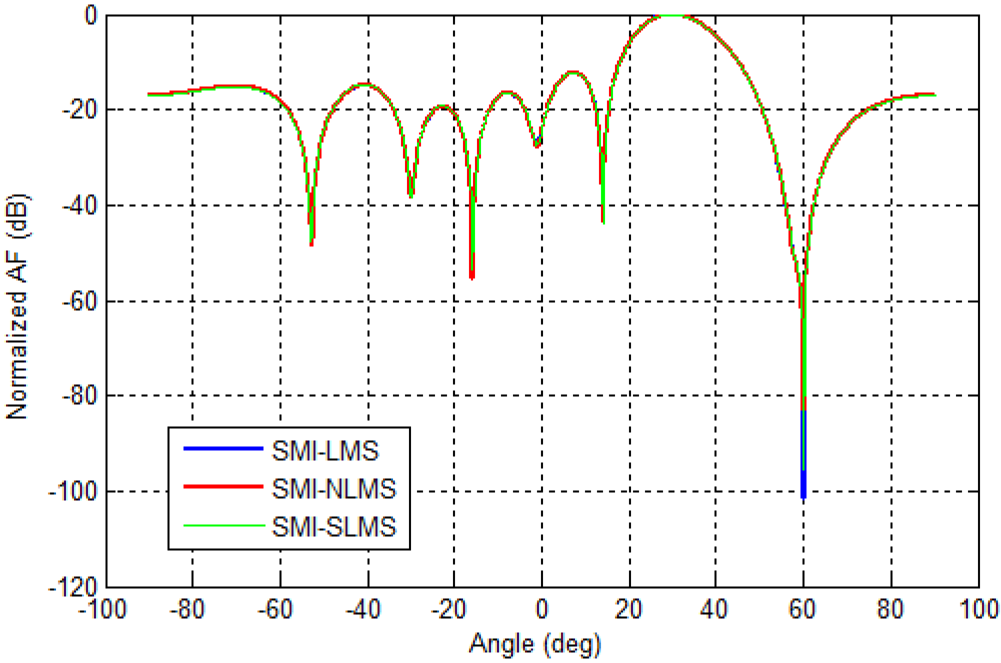

Fig 7: Simulation result for linear array using combined algorithms where μ = 0.05

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Table 1: Comparative analysis of combined beam forming algorithm for linear antenna array

Step Size(μ)	Parameters	SMI-LMS	SMI-RLS	LMS-RLS
0.2	Beam toward user	45^0	45^0	45^0
	Null-Null beam width	-	50^0	45^0
	Maximum SLL	-11dB	-14dB	-7dB
	Null towards interferer	No precise null at 50^0	50^0	No precise null at 50^0
0.1	Beam toward user	45^0	45^0	45^0
	Null-Null beam width	-	50^0	50^0
	Maximum SLL	-	-15dB	-15dB
	Null towards interferer	No precise null at 50^0	50^0	50^0
0.05	Beam toward user	45^0	45^0	45^0
	Null-Null beam width	50^0	50^0	50^0
	Maximum SLL	-15.5dB	-15.5dB	-15.5dB
	Null towards interferer	50^0	50^0	50^0

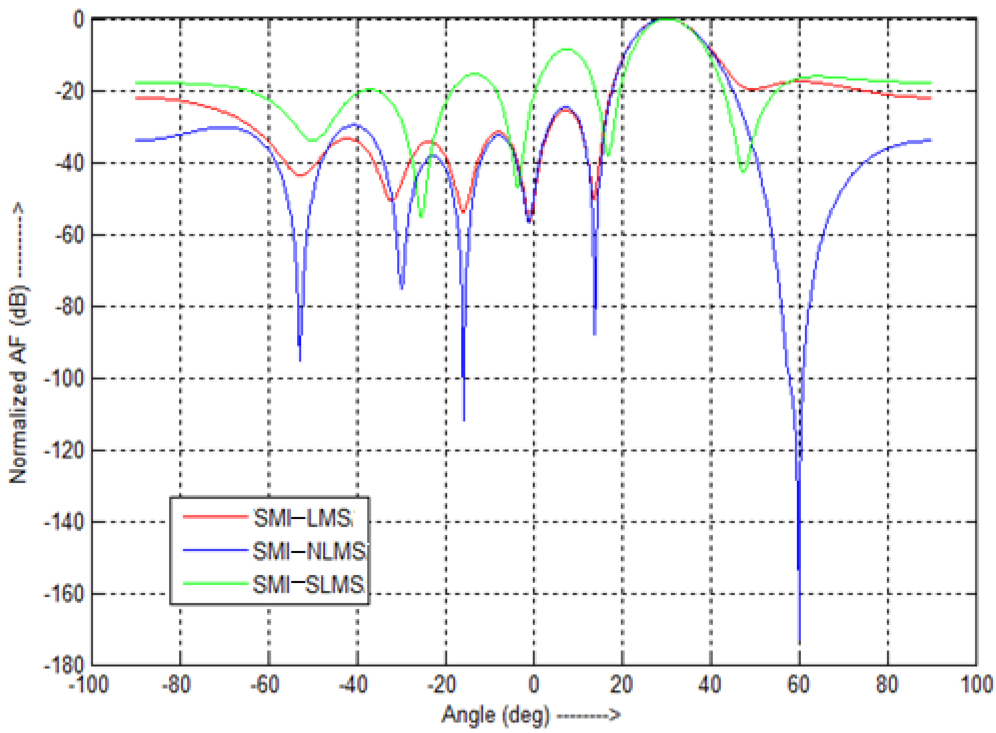

Fig 8: Simulation result for planar array using combined algorithms where μ = 0.2

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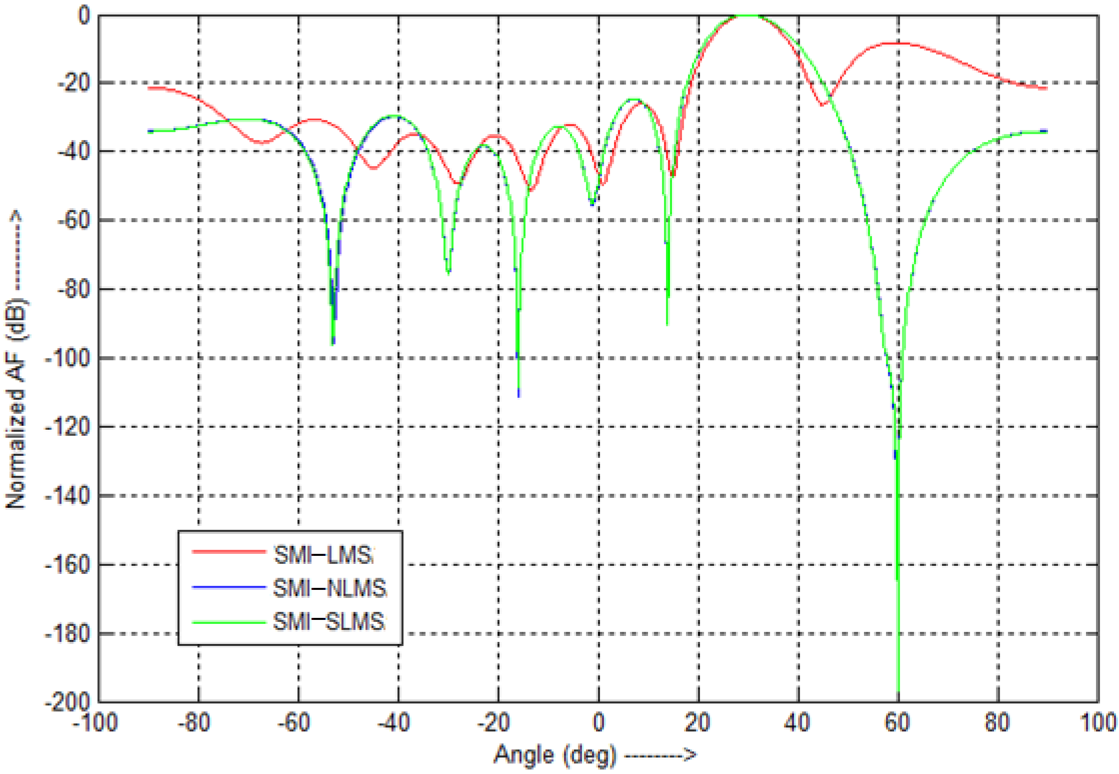

Fig 9: Simulation result for planar array using combined algorithms where μ = 0.1

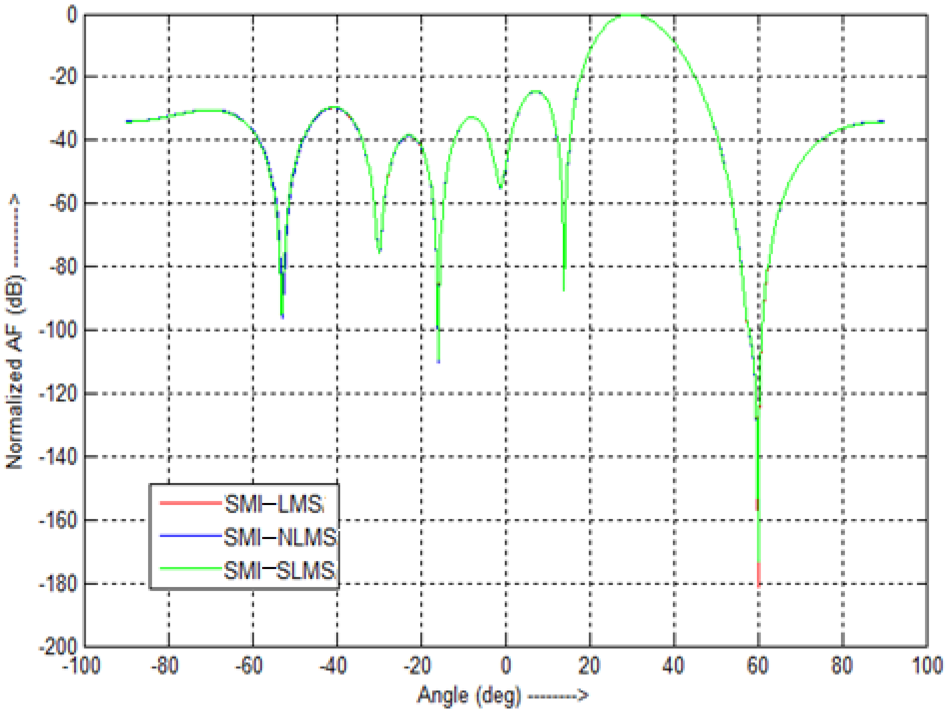

Fig 10: Simulation result for planar array using combined algorithms where μ = 0.04

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Table 2: Comparative analysis of combined beam forming algorithm for planar antenna array

Step Size(μ)	Parameters	SMI-LMS	SMI-RLS	LMS-RLS
0.2	Beam toward user	35^0	35^0	35^0
	Null-Null beam width	-	50^0	35^0
	Maximum SLL	-15dB	-20dB	-7dB
	Null towards interferer	No precise null at 50^0	50^0	No precise null at 50^0
0.1	Beam toward user	35^0	35^0	35^0
	Null-Null beam width	30^0	50^0	50^0
	Maximum SLL	-15dB	-20dB	-20dB
	Null towards interferer	No precise null at 50^0	50^0	50^0
0.04	Beam toward user	35^0	35^0	35^0
	Null-Null beam width	50^0	50^0	50^0
	Maximum SLL	-20dB	-20dB	-20dB
	Null towards interferer	50^0	50^0	50^0

CONCLUSION

For linear and planar smart antenna arrays almost similar patterns are obtained using SMI-LMS, SMI-NLMS and SMI-SLMS algorithms for various convergence parameters. For linear antenna array side lobe levels obtained for SMI-LMS, SMIRLS and LMS-RLS are -12.28dB, -28.26dB and -31.04dB respectively. In the work, presented in chapter 6, SLL achieved using LMS = -13dB, NLMS = -13dB, SMI = -14.7dB, RLS = -22dB. Improvement in SLL can be achieved by selecting lower value of block length. Similarly for planar antenna array, side lobe levels obtained for SMILMS, SMI-RLS and LMS-RLS are -24dB, -26dB and -27dB respectively for SNR value of 20dB. In the work, presented in chapter 7, SLL achieved using LMS, NLMS, SLMS, SMI and RLS are -26dB, -25dB, -24dB, -17dB and -22dB respectively for SNR value of 20dB. Minimum side lobe level is obtained using LMS-RLS algorithm with better convergence and minimum square error. Also performance of LMS-RLS algorithm is better for noisy environment compared to SMI-RLS algorithm in terms of convergence and square error. The reverse algorithm like LMS-SMI, NLMS-SMI, SLMS-SMI and RLS-SMI are not possible, because in SMI there is no such option to include previous weight of any algorithm like LMS, NLMS, SLMS and RLS. In reverse algorithm RLS-LMS, grating lobe appears with same parameters and also the square error is high

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