Seminar/ Project Title

A Seminar/Project Report

Submitted by

Mr. Student Name

(13MV010)

To the Savitribai Phule Pune University, Pune

In partial fulfillment for the final examination of

Bachelor of Engineering

In

DEPARTMENT OF COMPUTER ENGINEERING

Under the Guidance of

Prof. A.B. CDEF

DEPARTMENT OF COMPUTER ENGINEERING

Modern Education Society's College of Engineering

September 2018

Certificate

This is to certify that the thesis entitled: **Title of Project** submitted by **Mr./Ms. Student Name** is a bonafide record of the work carried out by him towards the partial fulfillment of the requirements of Savitribai Pule Pune University, for the final examination of Bachelor of Engineering in Computer Engineering, under my supervision and guidance.

Prof. Guide name
Assistant Professor

Dr. Name of HOD
HOD
Computer Engineering
Date:
Place: Pune

Dr. Name of Principal
Principal
MES COE, Pune-1

This report has been examined by us as per the Savitribai Pule Pune University requirements at **MES COE, Pune-1** on (date):

Signature
Name:
Internal Examiner

Signature
Name:
External Examiner

Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Place: Pune
Date:

Signature of the Student
Name:
PRN:

Acknowledgement

Date: **Student name**

Abstract

The beam steering array antennas,whose radiation pattern can be adjusted in accordance with particular optimum criteria, are called smart antennas. A smart antenna is actually combination of an array of individual antenna elements along with a dedicated signal processing algorithm. The radiation patterns a smart antenna are controlled using algorithms based upon certain criteria.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Types

Following are the different adaptive antenna algorithms [1]:

1. Least Mean Squares Algorithm.
2. Sample Matrix Inversion Algorithm.
3. Recursive Least Square Algorithm.
4. Conjugate gradient method.
5. Constant Modulus Algorithm.

1.2 Background

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. The beamformer array output is given by,

$$y(t) = w^H \, x(t)$$

the optimum solution for the weight w_{opt} is given by,

$$w_{opt} = R^{-1} \, r$$

where, $r = E[d^*(t)x(t)]$ is the cross-correlation matrix between the desired signal and the received signal, $R = E[x(t)x^H(t)]$ is the auto-correlation matrix of the received signal also known as the covariance matrix.

1.3 Objectives

- Formulating the equation of the algorithm.
- Algorithm Analysis.
- Simulation using MATLAB.

Chapter 2

Fundamentals of Smart Antenna

2.1 Introduction

The term “smart” refers to the antenna array system that can adapt its radiation pattern according to the need of the user based on a particular criteria. This is done by multiplying each antenna element output by the complex weight that is present in smart antenna system. The complex weight is obtained in many different ways, needs to be adaptive in nature. The adaptation can be achieved when the array is transmitting and receiving [1].

2.2 Smart Antenna

Smart Antenna systems provide number of significant advantages in wireless communications systems. These include reducing multipath fading, increasing system capacity, increased frequency reuse, sidelobe canceling or null steering, instantaneous tracking of moving sources and the range of a base station. The main functions of smart antennas are: estimation of direction of arrival (DOA) and beamforming. Algorithms like Capon, MUSIC, ESPRIT, etc. are used for estimating the DOA[1].

Table 2.1: Beamforming Performance Criterion

Criterion	No.	Performance
A	0	55
B	1	64
C	2	47
D	3	41

2.3 Beamforming

The fixed beamforimng algorithm works if the noise and direction of arrival of the desired signals and the interference signals in the environment is not changing. However in practice these may not appear always, so the task of adaptive Beamforming is to estimate the optimal weights for the antenna array system for a rapidly changing environment of channel and DOA. Adaptive Beamforming algorithms have to iteratively estimate the optimum weights to the antenna array system and adapt to the changing signal directions and noise channel states [2].

Chapter 3

Methodology

3.1 Modelling

Here,we have simulated sample-by sample adaptive beam-former using least mean square (LMS) algorithm and constant modulus algorithm (CMA). The weight vector W is calculated using the statistics of signal x(t) arriving from the antenna array. An adaptive processor will minimize the error e(t) between a desired signal d(t) and the array output y(t) [5].

3.2 Least Mean Squares

LMS algorithm uses steepest decent method, the output of the steepest decent method is as follows [4] :

$$W(n+1) = W(n) + 2\mu E[e(t)x(t)] \tag{3.1}$$

where, μ is a gain constant and controls the rate of adaptation. Step size μ should be chosen in a range in which convergence is ensured [**?**], as,

$$0 < \mu < \frac{2}{\lambda_{max}}$$

where, λ_{max} is the largest eigen value of correlation matrix *R*.
Equation (3.1) is the equation of the LMS algorithm [4]. The weights obtained by the LMS algorithm are only the estimates, but these estimates improve gradually with time as the weights are adjusted for more samples and the filter learns the characteristics of the signals.In practice weight vector 'w' never reaches the theoretical optimum (the Wiener solution i.e. w_{opt}), but fluctuates about it.

Chapter 4

Simulation

In the presence of two interfering signals and noise,both amplitude and phase comparison between desired signal and estimated output,beam patterns of the smart antennas and learning characteristics of the above mentioned algorithms are compared and analyzed. In the simulation,the smart antenna of 8 elements has been taken.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[5].

4.1 LMS

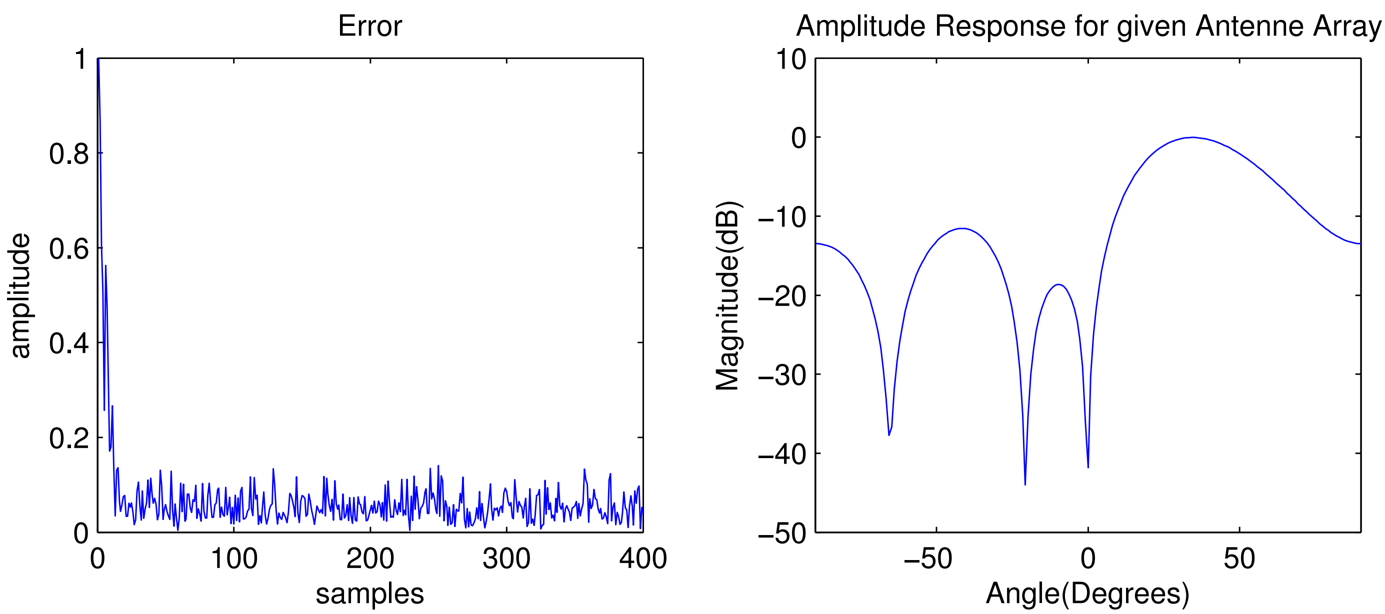

Figure 4.1: Error and amplitude response plots for LMS

Chapter 5

Conclusion

- CMA is a blind adaptive beamforming algorithm and LMS is a non-blind adaptive beamforming algorithm.
- The advantage of the CMA is the fact that it only needs the instantaneous amplitude of the array output $|y(n)|$ and therefore no synchronization is required between d and y signals.

References

[1] F. Gross, *Smart Antennas For Wireless Communication*, Mcgraw hill, September 14, 2005.

[2] L.C.Godara, *Smart Antennas*, 2004, CRC Press.

[3] H. L. Van Trees, *Optimum Array Processing,* Wiley, NY, 2002.

[4] Ifeachor, Emmanuel C., and Barrie W. Jervis. *Adaptive Digital Filters. Digital Signal Processing: A Practical Approach.* Second ed. Harlow, England: Prentice Hall, 2002. 650-660. Print.

[5] Das, S., " Smart antenna design for wireless communication using adaptive beam-forming approach," *TENCON 2008 - 2008 IEEE Region 10 Conference* , vol., no., pp.1,5, 19-21 Nov. 2008.