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Estimation of DOA and Beamforming For Wireless Networks

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ABSTRACT: In recent years there has been rapid growth in the area of wireless communication. This demands for more system capacity and also reduction in interference as low as possible.This leads to the application of Smart Antenna (Array of antenna and signal processing) in wireless communication, which increases channel capacity, range coverage and reduces interference. This is achieved through the DOA (Direction of Arrival) estimation and Beamforming technique.In DOA estimation, the direction in which the array has maximum response for the desired user is calculated. There are different methods for DOA estimation. In this work the MUSIC (Multiple Signal Classification) algorithm for DOA estimation is done, which is useful for Beamforming. Beamforming is done to receive signals radiated from a specific direction and attenuate signals from other directions (or) otherwise radiate signals in specific direction.
Digital Beamforming is based on capturing RF signals and converting into two streams of base band Inphase and Quadrature signals. Beamforming is carried out by weighing the digital signals thereby adjusting the amplitude and phase such that when added together they form desired beams. Conventional Beamforming under independent type and the RLS (Recursive Least Square) Beamforming under the statistical type and a comparison between the two have been implemented in MATLAB.

I. INTRODUCTION

Antenna Basics

Use of antennas for wireless communication systems has gain a lot of importance in the recent years.[1-3 A special breed of antenna which is dominating the wireless communication domain is named as Smart Antenna. Smart antenna is a combination of antenna arrays and digital signal processing units in order to improve reception and emission radiation patterns. It

can adjust itself dynamically according to the signal environment. Antenna array can be defined as a collection of many antenna elements which are placed in various pre-decided geographical location. This arrangement is made keeping a fixed location as a reference point. The advanced version of the antenna array is the adaptive antenna array. The adaptive antenna array has an internal feedback system which modifies its beam pattern according to the requirement. [4-7]
This antenna array used to increase the channel capacity, extend the coverage, steer multiple beams to track mobiles. Moreover it can also be used to reduce multipath fading and co-channel interference. Increasing the channel capacity and coverage largely depends on the distribution of the mobile stations or users. Channel capacity is defined by the number of users that can be serviced in a particular area. Again coverage area is the stipulated distance up to which effective communication can be made between the mobile and base station. The coverage area of an antenna can be increased by increasing the radiation power of the broadcasting antenna. Generally, in cities where the population is dense, more concentration is given to the channel capacity. Again in small towns and villages where there are less number of users
present but the users are sparsely distributed then we increase the coverage area so that all the users can be serviced properly. Another important feature of this antenna array is to reduce the amount of interference caused by unwanted signals and noise. Interference can almost be eliminated by reducing the interference while down-linking and up-liking. This can be better explained using the Spatial Division Multiple Access (SDMA) technique. SDMA technique incorporates the use of satellite to provide service to various geographical locations.

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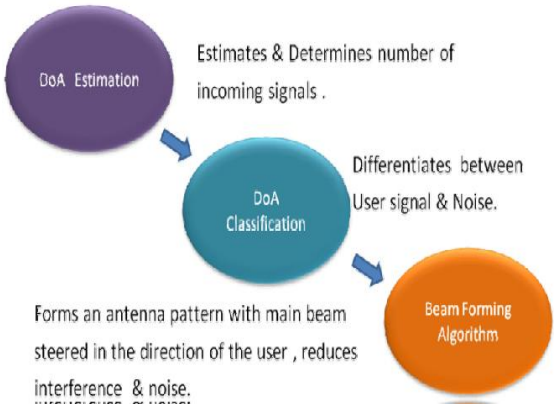
II. SYSTEM DESCRIPTION

The system which is used for the operation can be sub divided into three parts. These are mainly DOA estimation, DOA classification and Beamforming. Each of these performs there assigned operations.



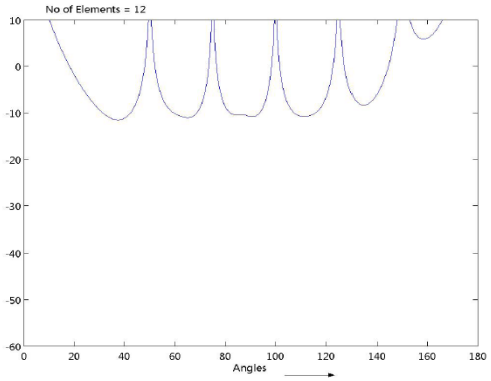
DOA Estimation

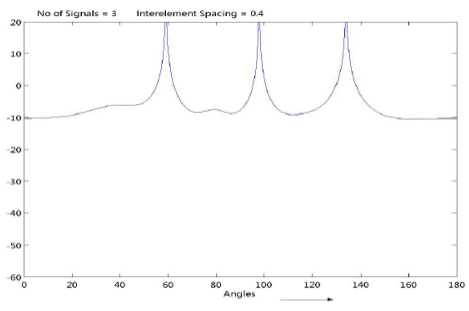
In wireless communication it is useful to gather information about the position of the users. Methods which extract this information from the incoming signals are called Direction of Arrival (DOA) Estimation Methods. The data received by the array is used to estimate the direction of arrival of the signals. The result obtained from DOA estimation is then utilized to build the adaptive beamformers. We have different types of algorithms for DOA.[9-13] For the optimized performance of the antenna array the DOA algorithm should work properly. A DOA algorithm depends on many parameters. These parameters are number of elements in the array, inter-element spacing, number of signal samples, spatial distribution etc. There are mainly two categories of DOA
algorithms available. The first type is called the Spectral Estimation Methods. And the second type is the Eigen-structure Methods. There are some more types of algorithm which do not fit any of these categories.
algorithms available. The first type is called the Spectral Estimation Methods. And the second type is the Eigen-structure Methods. There are some more types of algorithm which do not fit any of these categories. [14-15]

Simulation Results of Linear array:

To analyze the performance of the MUSIC algorithm we compared in two cases. First case we observed MUSIC Spectrum by cahnging the Number of array elements. Fig 2.1a shows the MUSIC spectrum generated with 12 array elements, where Fig 2.1b figure shows the MUSIC spectrum generated with 8 array elements. It is seen that if we use more array elements it improves the resolution of the MUSIC spectrum. [8][16]

Matlab





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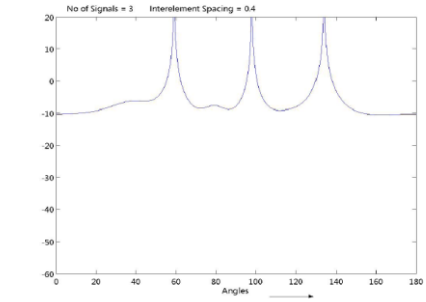
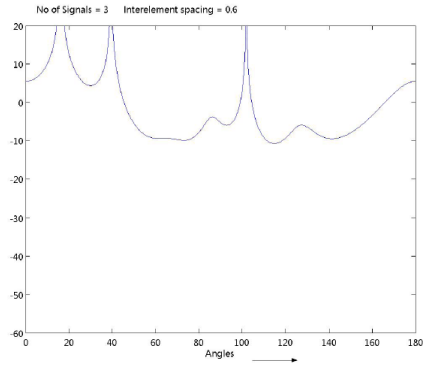
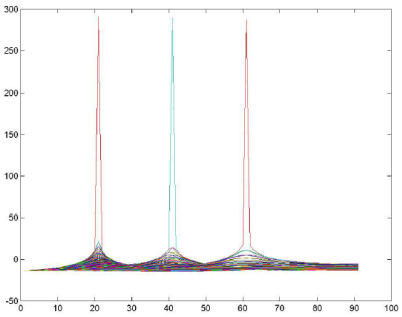
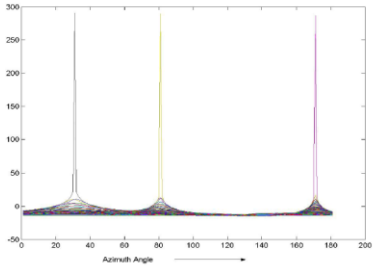
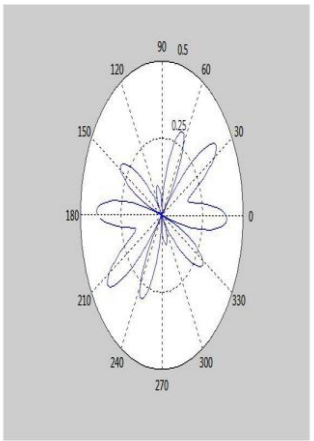




DOA estimation output of UCA: Elevation Angle







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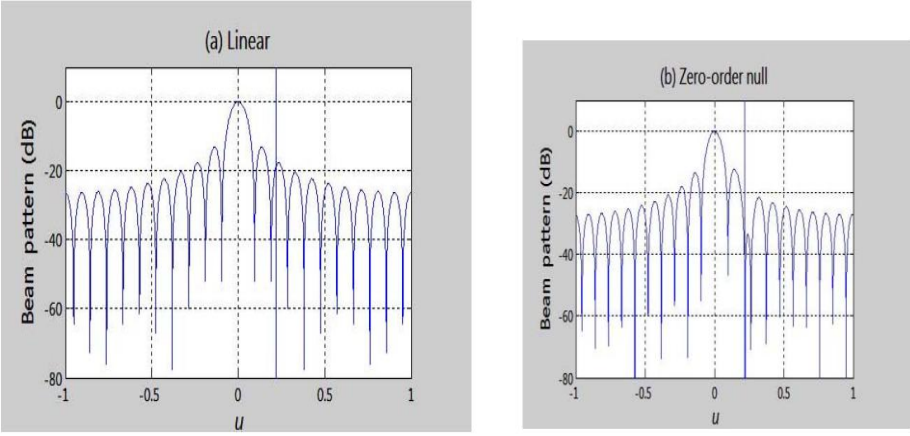

III. CONCLUSION

The main objective of our project is to throw light on the increase channel capacity, range coverage and reduces interference, so that the wireless communication can be made more effective. And we have attained our objective by estimating the desired input signal by using the MUSIC Algorithm which is simple and it well suites all beamforming algorithms effectively. Also we have compared the conventional and Recursive Least Square Algorithms for beamforming by using the MATLAB software. The MUSIC Algorithm enables us to avoid the interference and the beamforming techniques we have discussed enables us to minimize the amount of memory needed to store the signal strength which in turn enables in increasing the channel capacity. Our Future work in this project will be to propose an effective beamforming algorithm with less Signal to Noise Ratio and the interference issues we have faced in the conventional and Recursive Least Square Beamforming Algorithms. So that we can come up with a better wireless communication model.

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