Reducing the BER by MIMO OFDM beam-forming in Smart Antenna MANET system

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Abstract: MIMO-OFDM system with beam-forming is analyzed. The point-to-point multiple-input-multiple-output (MIMO) and orthogonal frequency division multiplexing (OFDM) techniques are combine to provide higher data rate in recent wireless standards, that is 802.11x families. By using smart antenna arrays in MIMO, beamforming is improved by Taylor and tinning, beamforming can be accepted to enhance the receiver signal to noise ratio (SNR) which in returns decreases the bit error rate (BER).

Index Terms- *MIMO-OFDM, SNR, BER, Smart Antenna, MANET.*

I. INTRODUCTION

MANET is also called as wireless ad-hoc network that typically encompasses a directed networking surroundings on high of the link layer ad-hoc network they consists of set of mobile node connected wirelessly during a self organized while not having a hard and fast infrastructure. Manet nodes are absolved to move every which way as a configuration amendment often. Every node can behave as a router as they forward traffic to alternative fixed node within the network. Manet could operate as standalone fashion or they'll be the part of larger net. They are kind extremely dynamic autonomous topology with the presence of 1 or multiple totally different transceivers between nodes. The most challenge for Manet is to equip every device to unendingly maintain the knowledge needed to properly path traffic.[1]

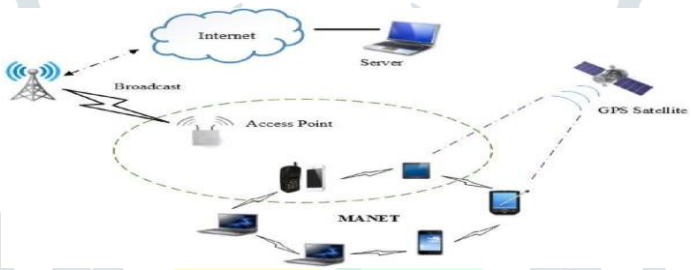

Figure1. MANET Architecture

Smart antenna

Smart antenna is comprised of no. of individual antennas and associated signal processors which give the "smart" part. Smart antenna will use each for the signal transmission and signal reception. It automatically changes direction of radiation patterns in wireless network. The key advantage to employ a smart antenna is to decrease the whole system power, drop in communication interference, and rise in system capability or improve in system power effectiveness. Smart antenna at the receivers offers the reduction of signal lose in multipath weakening, which suggest additional overall strong signal quality independent of variation of transmitted signal.[2]

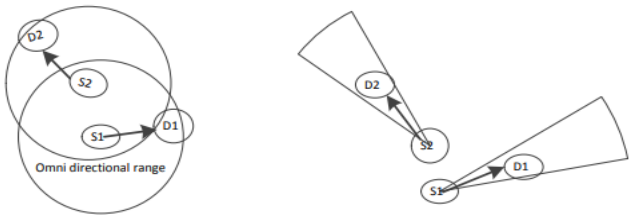

Figure2. Capacity of a network with omni directional antennas and a network with smart antennas.

MIMO (Multiple Input Multiple Output)

By the term it is clear that at transmitter or receiver end we have more than one antenna to improve channel robustness and throughput. A MIMO has a full process for implementation on system which may increase the channels but gives more benefits. The main idea for MIMO is "space time signal processing" means it has a logical extension in smart antenna for wireless communication.[3]

The two key phases for MIMO are given below:

- **Spatial diversity:** It also called as transmitter and receiver diversity. This format is used to improve signal to noise ratio. They are defined by extending consistency of system with concern of different types of fading.
- **Spatial multiplexing:** It is used to higher the data rate by utilizing extra path present in network.

OFDM(Orthogonal Frequency Division multiplexing)

An OFDM use a numbers of carriers called as multicarrier modulation. it work in process that is a modulated data is functional to a carrier then sideband are extend on both side so that data is successfully demodulated but when signal are send very close then they need to distanced so that by use of filter at receiver signal are separated with guard band. But it is not happened in OFDM because it is orthogonal and interference is reduced by carrier spacing equal to reciprocal period.[4]

Tapering of array

It is used for side-lobe reduction named as tapering. In this tapering is made from center to end by means of radiation if center radiates more high then minor lobes are reduced with respect to some instruction[5]

Thinning

An antenna array is full of elements. By using a phase variable an antenna search a desired direction and control excitation or feeding element. An thinning a array decrease some elements of antenna array for having a desired radiation by mean of low side lobe in short time.

II. Problem Statement

The purpose of paper is to find a stable and reliable techniques or method that improve high data rate, signal to noise ratio and bit error rate of wireless communication network.

Three major functions are performed in this research paper, the smart antenna which overcome omni-directional drawbacks and analyzed, the uniform linear array is generate which enhance performance of smart antenna, the Beam-forming is applied on MIMO-OFDM technique to reduce bit error rate.

- Omnidirectional antenna radiates equally and symmetrically in all directions due to which there is loss of large amount of power, interference in such system is more, gain is less towards particular user.
- In directional antennas side lobe is a big problem. Side lobes represent the wastage of energy. These side lobes can be controlled by carefully controlling the power radiated by each antenna element. But ultra-low side lobes creates other problem like precise control of power of every antenna element is required which raises the cost of the design.

Smart antenna is achieving popularity nowadays. The foremost vital part in smart antenna is beam-forming and therefore major benefit of beam-forming is that “phase shifting” and “array weighing” can be implemented on digital data rather than in hardware. These weights are accustomed guide the antenna array beam within the path of interest, thereby enhancing SNR.

III. Design and Implementation

1) Omnidirectional Radiation Pattern

MANETs use Omni-directional antenna for sending data and receiving. Omni-directional is basic antenna used in SAS, radiation pattern of eight node is shown in figure 3.

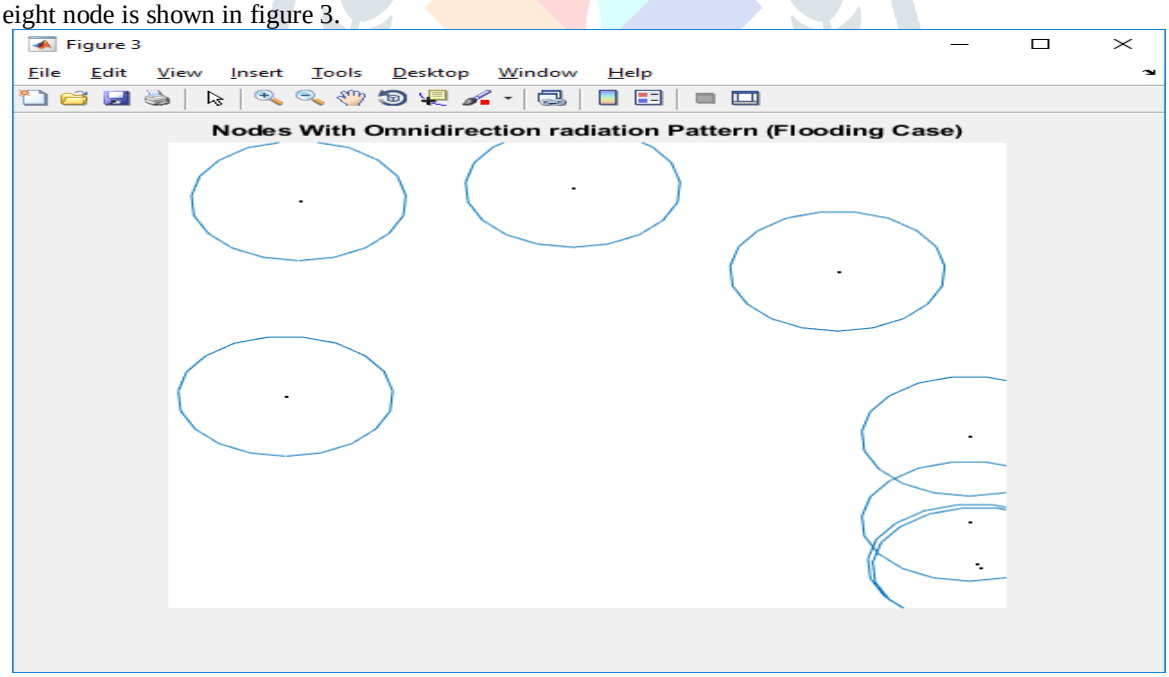

Figure 3: Omni-directional radiation pattern

As in ad-hoc network nodes radiate in all directions equally and symmetrically forming a circular pattern. This formed circular pattern is called omni-directional radiation pattern of nodes. In ad-hoc network as if number of nodes in the network are increased then it’s radiation pattern overlap with each other.

2) Sectoring

Switched beam (sectorized) antenna systems in which multiple fixed beams are possible. The switched beam systems present a predetermined set of beams which can be selected as appropriate.

Sectoring can vary from 2 sectors to many more, if the user in a particular direction are less then no of sectoring should be large, if number of users are more than number of sectors should be less. Figure 4 and 5 shows the four and 17 sectors respectively.

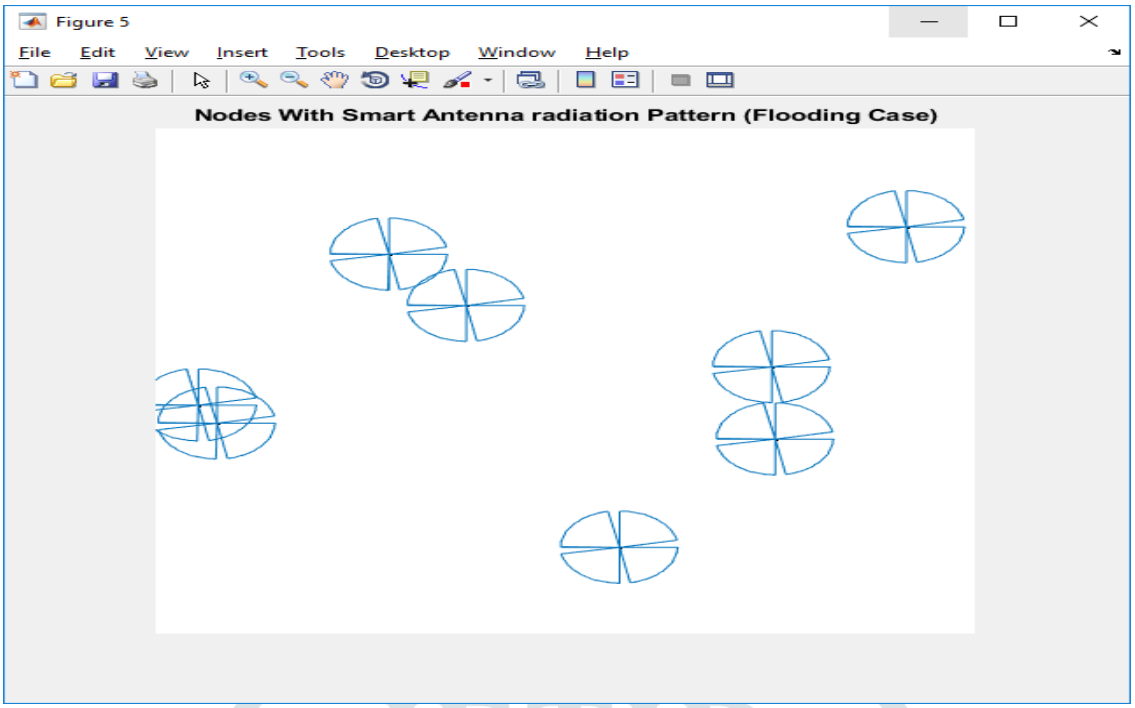

Figure 4: Four sectors

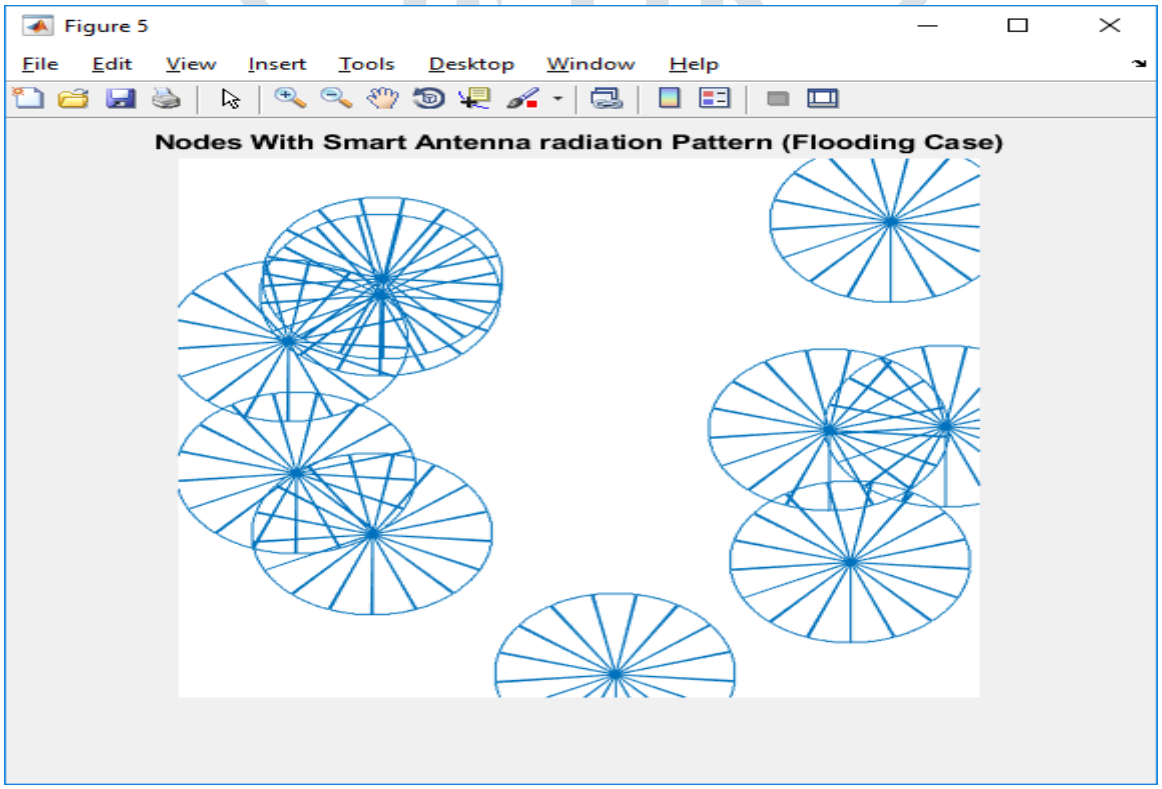

Figure 5: Seventeen Sectors

3) Communication in Omnidirection Antenna

Figure 6 showing the communication between the nodes. Randomly any node can be selected as transmitter and any node can be selected as receiver then the communication takes place between transmitter and receiver. Any node can transmit or receive signals from other nodes. An antenna which is acting as a transmitter at first time may appear as a receiver for the next time.

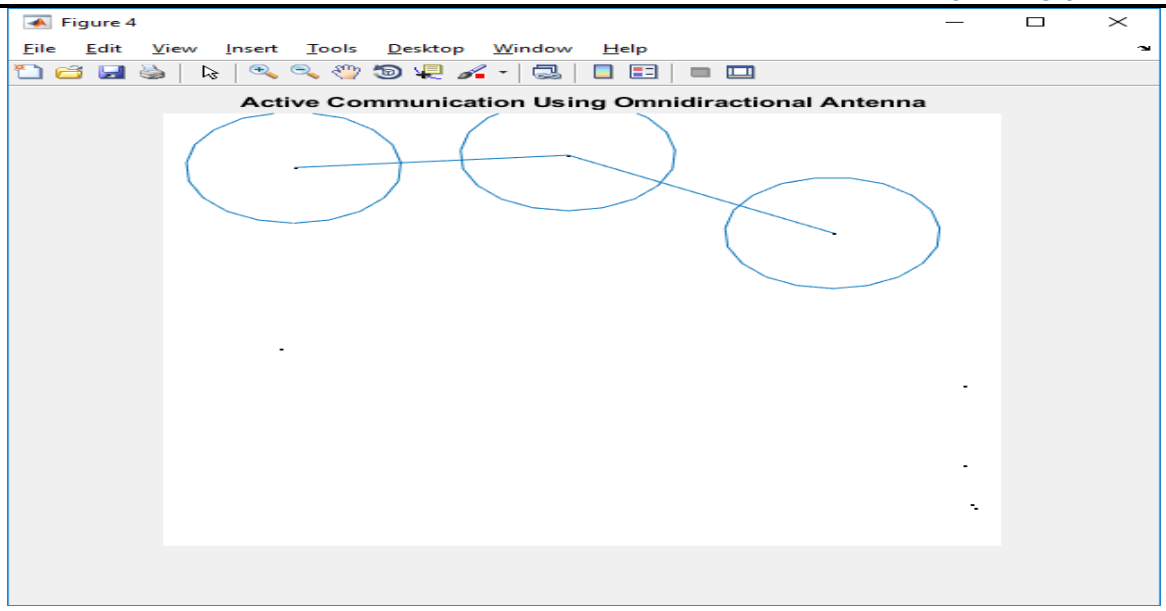

Figure6: Communication in Nodes

Here out of eight nodes three nodes are communicating and five nodes are not communicating so they are not showing their radiation pattern.
Similarly, in the following cases the nodes which are communicating with each other are showing their radiation pattern and others are keeping silent and saving their energy by not radiating.

4) Communication in Smart Antenna System

A smart antenna give a directional beam at wanted path and by mean of this we save power, channel reuse. Here out of eight nodes three nodes are communicating and five nodes are not communicating so they are not showing their radiation pattern. Similarly, in the following cases the nodes which are communicating with each other are showing their radiation pattern and others are keeping silent and saving their energy by not radiating.

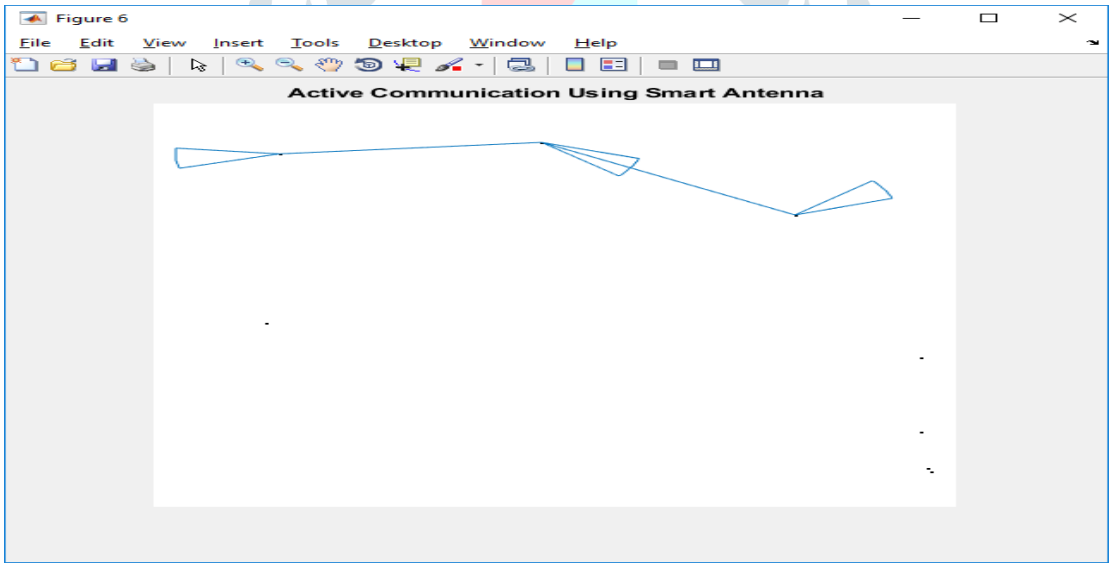

Figure7: Communication in Smart Antenna

In antenna **side lobe** is made by other radiation source and never be a “main lobe”. In this a signal radiates at different angle and a null angle where its value becomes zero. But in smart antenna a signal radiates at main path with having large strength and also called as main lobe.

The **rectangular plot** for elevation of 31 degree is also analysed and compared. A rectangular radiation plot, an alternative presentation method to a polar plot. Figure shows the rectangular plot and polar plot respectively with elevation of 31 deg and broadside at 0 deg, which is the main lobe with few side slobs adjacent to the main lobe.

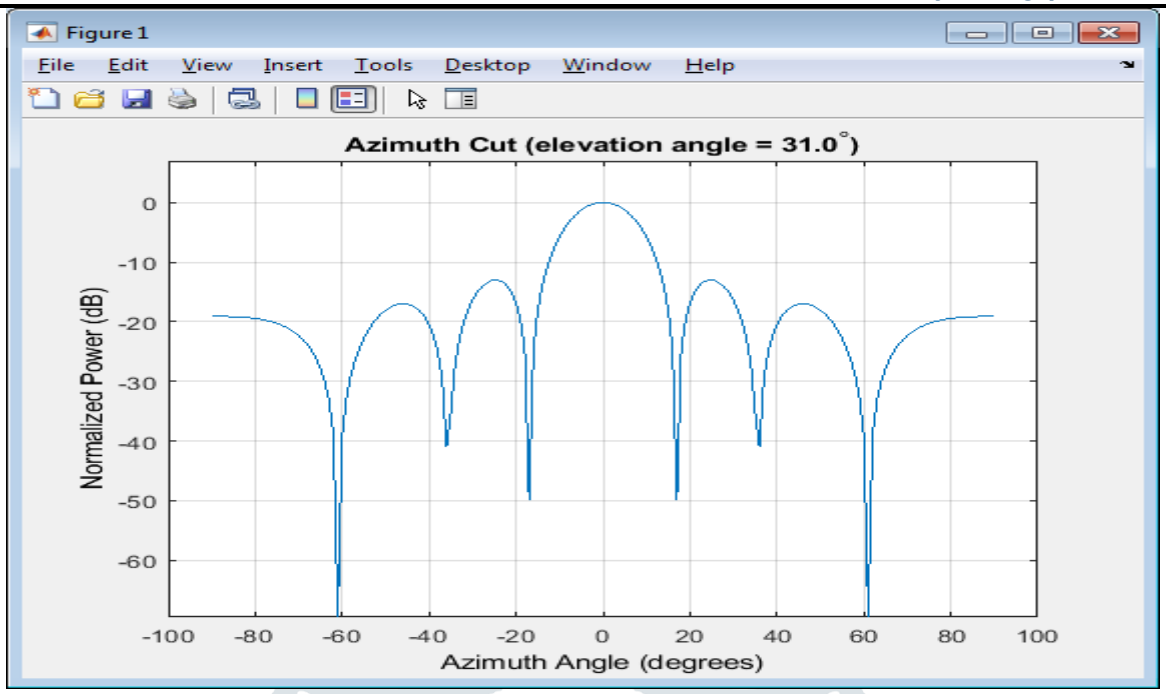

Figure8: Rectangular Plot

Sidelobes are an unfortunate reality of all directional antennas. They are a consequence of nature and are directly related to diffraction effects in light – and there are similar effects in sound and water waves. Diffraction occurs whenever there is a sharp discontinuity in a radiating or reflecting surface. On the antenna arrays so far described we have a number of elements all radiating and suddenly the antenna ends, which creates diffraction or sidelobe type effects. These effects can be minimized by carefully controlling the power radiated by each element such that, in general, the further an element is away from the centre the less power it should radiate.

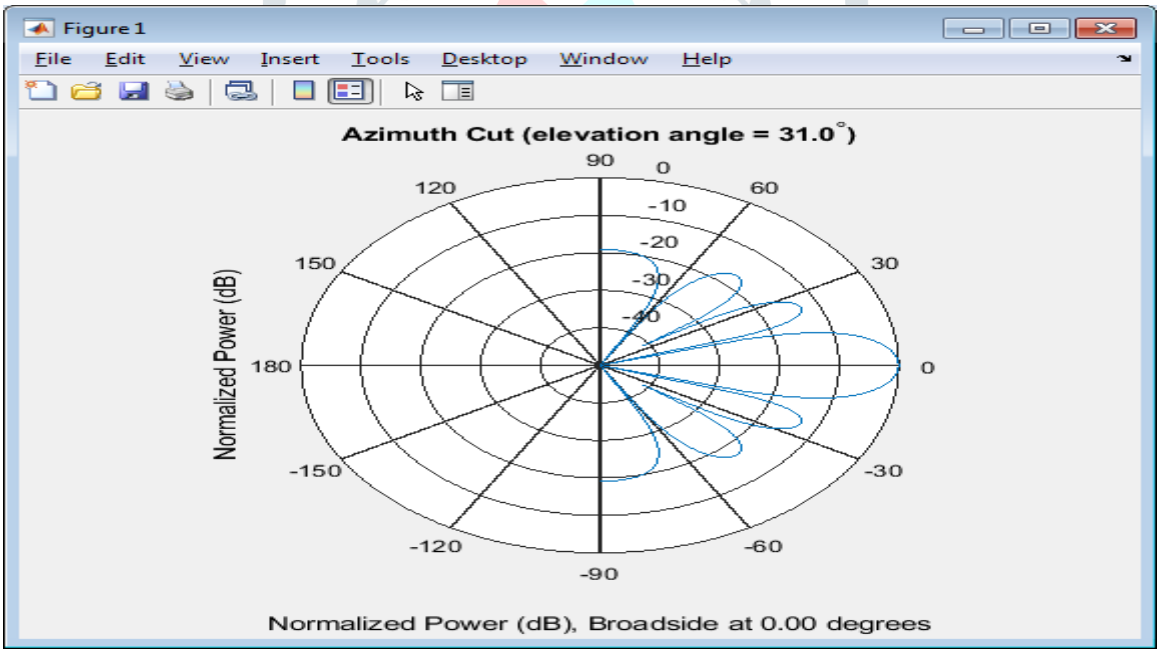

Figure9: Polar Plot

Array side lobes can be minimized by tightly controlling the amplitude/phase errors occurring in the different parts of the array and by amplitude/spatial tapers across the array. In this **Taylor window tapering** is done to reduce side lobes as shown in figure rectangular and polar plot respectively.

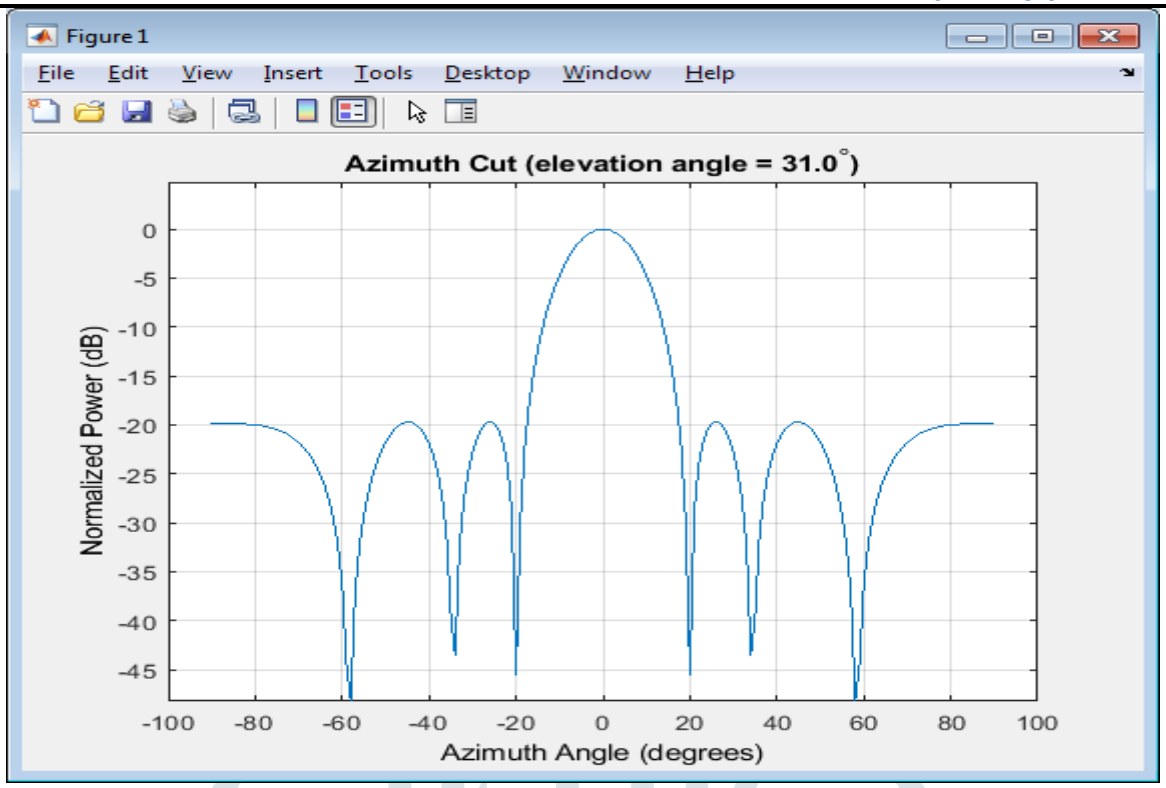

Figure10: Taylor window tapered Rectangular plot

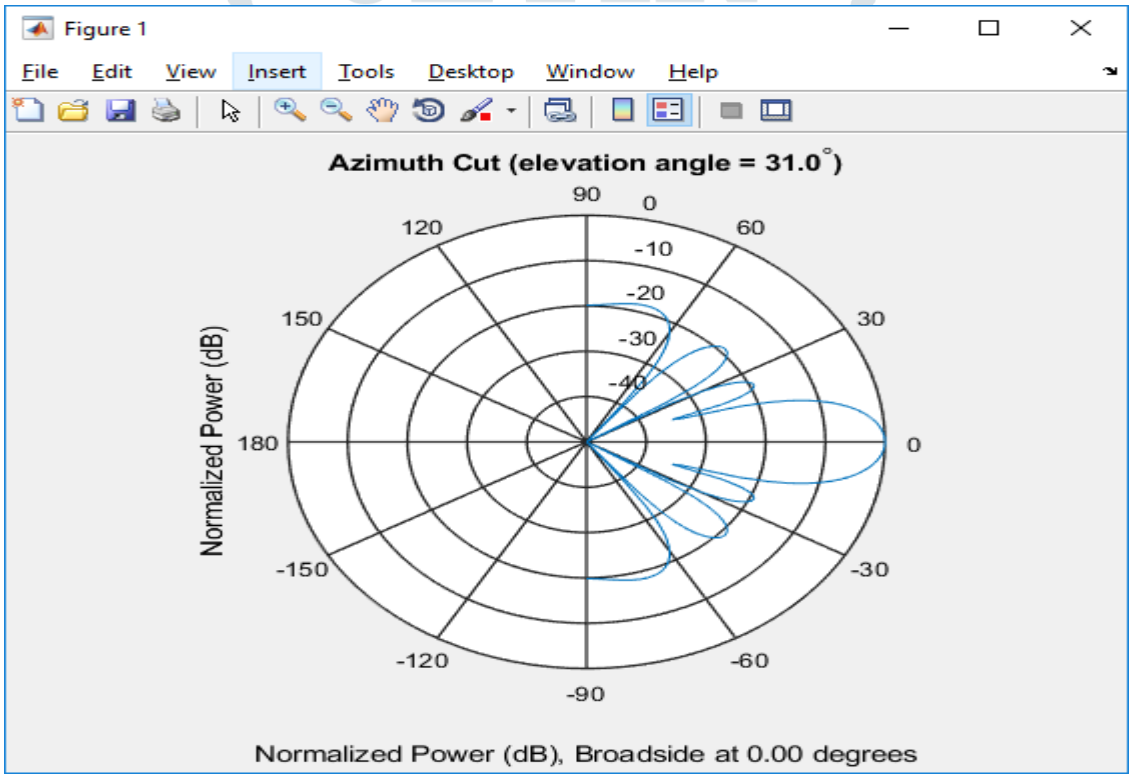

Figure11: Taylor window tapered Polar plot

Performance of smart antenna can also be improved by thinning of side lobes. Systematically eliminating the **antenna** array elements without ceasing the performance of the **antenna** array is known as **thinning**. Thinning is shown by figurein rectangular plot. Thinning is shown by figure in polar plot.

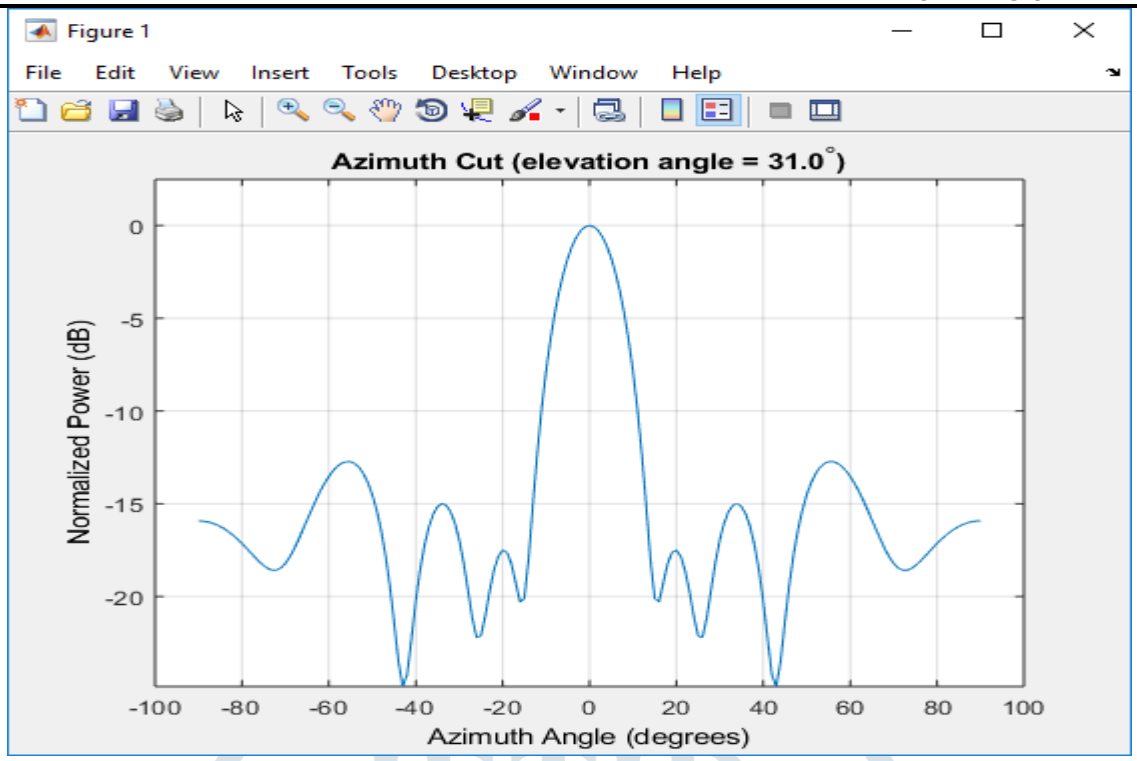

Figure12: Thinning of side-lobes in Rectangular Plot.

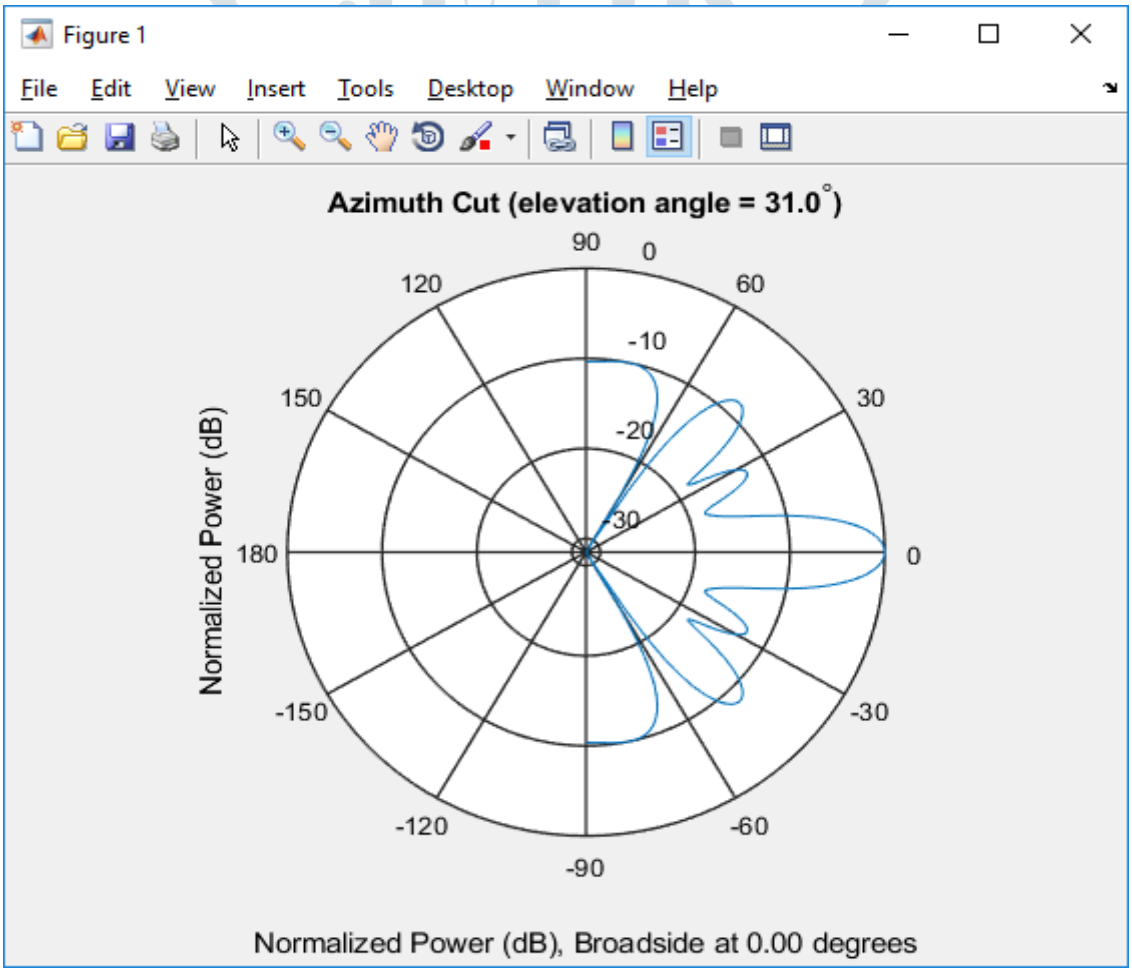

Figure13: Thinning of side lobes in Polar Plot.

Beam-forming:

To design a point-to-point "MIMO-OFDM system with beam-forming". In these days, a wireless communication makes a combination of MIMO and OFDM technique for getting a high data rate. To improve signal to noise ratio and reduce bit error rate a beam-forming is performed on MIMO-OFDM.

The MIMO is a term used which describe a multiple transmitters or multiple receivers system. An 8-element Universal Linear Array is designed at the base station as the transmitter while the mobile unit is the receiver also has multiple antennas.

The remaining configured of the system are given as, the transmitter power and gain is10 watts and -9 dB. The receiver is at rest and located at 2800 m away from transmitter, and having a 3 degrees boresight angle. An inference of 1 watt is also added with a receiver gain of -22 dB is suited at 9000 meters, 30 degrees off the transmitter's boresight.

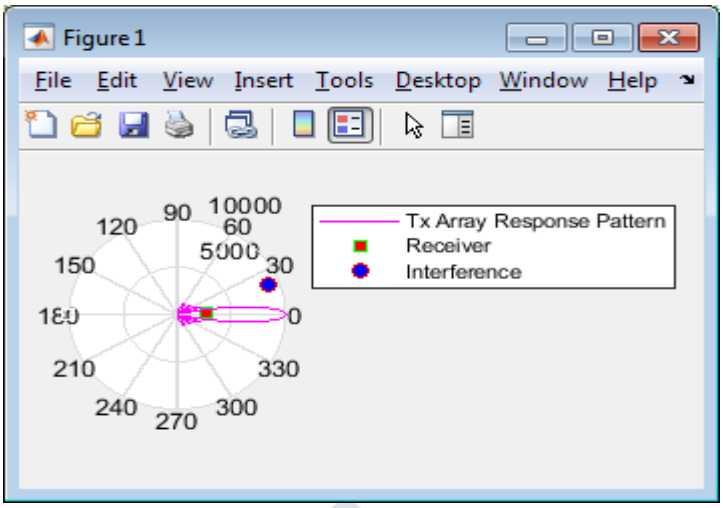

Figure14: Final beam receiver at 3degree

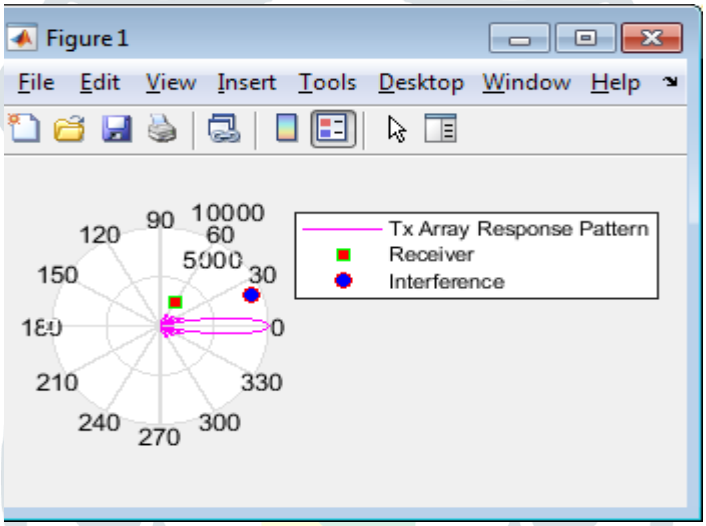

Figure15: Final beam receiver at 20degree

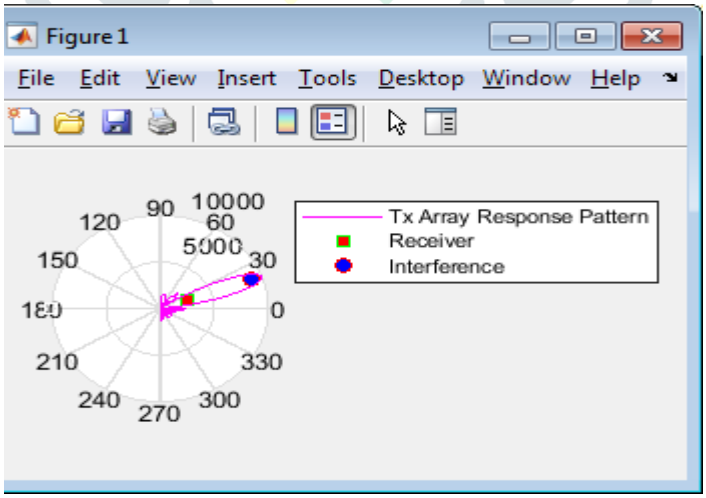

Figure16: Final beam receiver at 20deg in direction of beam interference at 20 degree

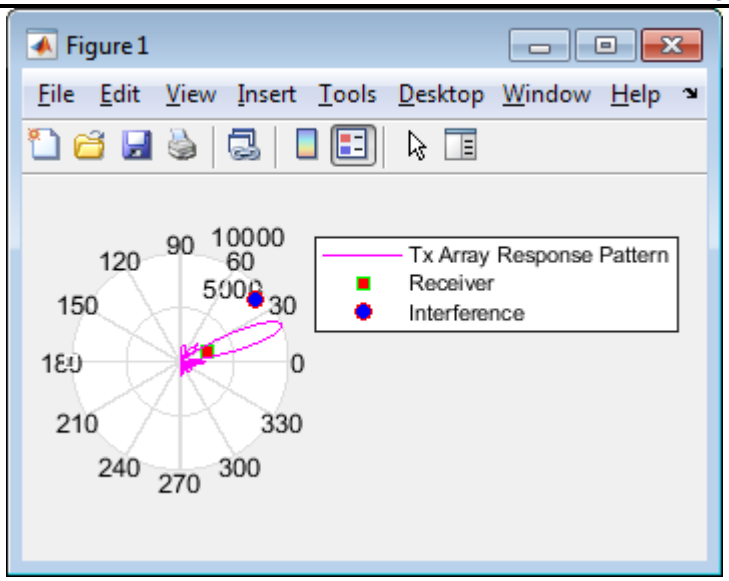

Figure17: Final beam receiver at 20degree in direction of beam interference at 40degree

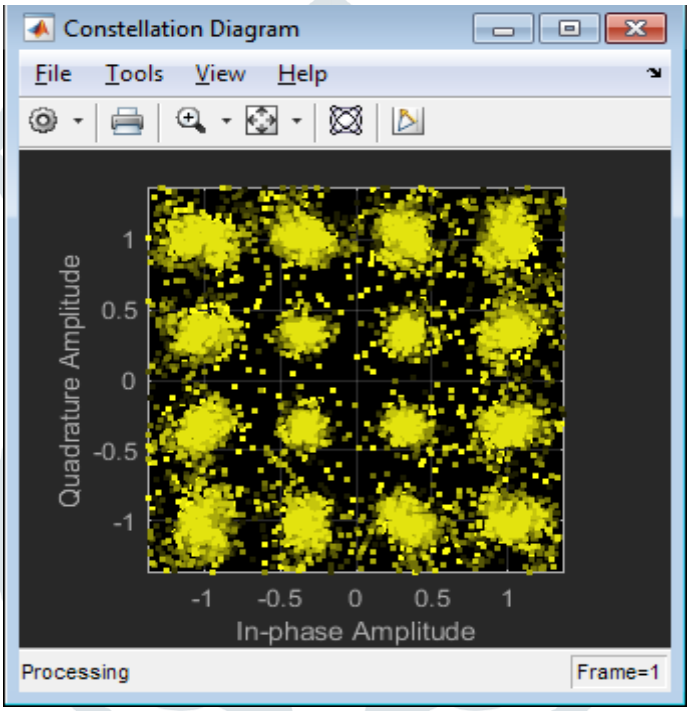

Figure18: Constellation Diagram

Table1. Final results beam receive at 20 degree and at interference 40 degree.

S. no.	BER	No. of Bits	No. of errors
1.	50.15%	30714	15404
2.	0.01%	30714	4
3.	0.01%	30714	4

By using a Taylor window and a tapering a uniform array is improved by means of getting high data rate and after that a beam-forming is done on MIMO-OFDM to reduce bit error rate. As above a table shows.

IV. CONCLUSION

Side-lobes are an unfortunate reality of all directional antennas. They are a consequence of nature and are directly related to diffraction effects in light – and there are similar effects in sound and water waves. Diffraction occurs whenever there is a sharp discontinuity in a radiating or reflecting surface. On the antenna arrays so far described we have a number of elements all radiating and suddenly the antenna ends, which creates diffraction or side-lobe type effects. Performance of smart antenna can also be improved by thinning of side lobes. Systematically eliminating the **antenna** array elements without ceasing the performance of the **antenna** array is known as **thinning**. Thinning is shown by figuring rectangular plot. A beam-forming and m-MIMO are every so often used like beam-forming in m-MIMO or subset of m-MIMO. In broad, to manage the path of wave-front by using weight and phase of signal a beam-forming uses multiple antennas. To decrease SNR and bit error rate a beam-forming is made on MIMO-OFDM.

REFERENCES

[1]. https://www.geeksforgeeks.org/manet-mobile-ad-hoc-network/.

[2]. Bindu Sharma, "AN INTRODUCTION TO SMART ANTENNA SYSTEM", International Journal of Business and Engineering Research Vol. 8 Nov.2014 ISSN: 0975-0479.Ivan D. Djokic, Zarko P. Barbaric, "Flight Control System Development Using Simulation – an Integrated Approach", Tehničkivjesnik 19, 2(2012), 287-294.

[3]. https://www.electronics-notes.com/articles/antennas-propagation/mimo/what-is-mimo-multiple-input-multiple-output-wireless-technology.php.

[4]. https://www.electronics-notes.com/articles/radio/multicarrier-modulation/ofdm-orthogonal-frequency-division-multiplexing-what-is-tutorial-basics.php.

[5]. Girdhar Chandra, "Design of Lowpass Fir Filter using Nuttall,Taylor and Tukey Window techniques", International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882.