# RADIATION PATTERN OF YAGI-UDA ANTENNA USING USRP ON GNU RADIO PLATFORM

**Sreethivya[1] M, Dhanya.M.G[2], Nimisha.C[3], Gandhiraj.R[4], Soman.K.P[5]**

[1]*M.Tech Student, Department of CEN, Amrita Vishwa Vidyapeetham, Tamilnadu, India*
[2]*M.Tech Student, Department of CEN, Amrita Vishwa Vidyapeetham, Tamilnadu, India*
[3]*M.Tech Student, Department of CEN, Amrita Vishwa Vidyapeetham, Tamilnadu, India*
[4]*Assistant Professor, Department of ECE, Amrita Vishwa Vidyapeetham, Tamilnadu, India*
[5]*Head of Department, Department of CEN, Amrita Vishwa Vidyapeetham, Tamilnadu, India*

## Abstract

*In this paper we are planning to realize radiation pattern of a Unidirectional Yagi-Uda antenna using USRP2 which is connected with GNU Radio. Our basic approach is to get radiation pattern for H-plane structured Yagi-Uda antenna at different angles (0-360°). The proposed method is of low cost and easy to implement with two USRP, two PC and a Yagi-Uda antenna. The platform which we have used for getting radiation pattern values is GNU Radio which is open source software.Yagi-Uda antenna is used for long distance communication since it has good directivity. It is designed with three pairs of oscillator, directors and active transducer. Oscillator is connected to the voltage feeder and active transducer incapacitates the wave from different sides of antenna.*

***Keywords:*** *Yagi-Uda antenna, GNU Radio, Radiation pattern, USRP2, Folded Dipole antenna.*

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

## 1. INTRODUCTION

In this paper we present radiation pattern of a unidirectional Yagi [2] antenna. The radiation pattern [2] is the outcome of scattered received energy which is different at different direction. In radiation pattern there are many sort of lobes appeared according to the received energy in different direction. A lobe can be a main lobe, side lobe, back lobe. Appearence of side lobe refers that presence of noise in received signal.

The Yagi antenna which has been already tuned to a particular frequency will vibrate/resonate to a same frequency radio signal. In general it is used at ground installations in satellite communication systems. A fundamental type Yagi-uda antenna includes three parallel elements and each measuring close to half electrical wavelengths. The frequency range of Yagi-Uda is from 30MHz to 3GHz. Power can be fed with coaxial cable at the point at which the feed line connects the driven element. A center fed, half wave dipole antenna is used as the driven element of Yagi-Uda antenna.

A Yagi antenna has a reflector, a driven element and one or more directors arranged on a boom in parallel. The electromagnetic enery is propogated from the antenna in the direction starting from driven element to directors. The antanna elements are very sensible to incoming electromagnetic field energy in this same direction. The Yagi antenna has a unidirectional radiation pattern. The more directors a yagi has, greater the forward gain. We have used a single director along with a reflector and a driven element.

## 2. WORKING PRINCIPLES OF YAGI ANTENNA

In general antenna in transmitter side converts electrical signals into radio waves and antenna in the receiver side exactly does the reverse process.

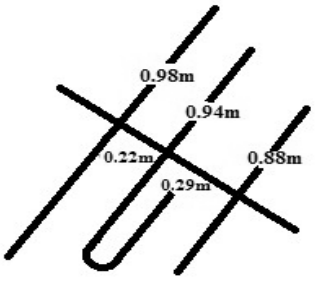


**Fig -1**: Yagi-Uda antenna design

The reflector used in yagi antenna acts as a mirror. It just reflects the electromagnetic waves. According to the reflector position the radiation pattern changes. Reflectors can act as a complete device for redirecting RF energy. It is integrated as a part of the yagi-uda antenna. A folded dipole element is used as a driven element in our yagi-Uda-antenna. Dipoles are resonate antennas, denoting that the elements serve as resonators.

## 3. GNU RADIO

GNU [5] Radio is a freely available open source software tool. Since it offers more number of signal processing blocks and control the software radios, the GNU Radio has numerous applications in academic environment to support real world radio system and wireless communication. It consists of C++ API and Python API manuals.

## 4. USRP

USRP [1] can be expanded as Universal Software Radio Peripheral. It supports following operating systems MacOS, Linux and Windows platforms. Primary driver for all Ettus Research products - including the USRP2 - is the UHD [7] (USRP Hardware Driver) software. UHD software is considered stable. It supports wide range of frequencies for wireless communication as a USRP mother board can support up to four daughter boards.

We have used the WBX-USRP2 which can cover frequency from 50MHz to 2.2GHz. We can set centre frequency in uhd-usrp sink/source block which carries the message signal and has a device address. That WBX-USRP2 is a wide bandwidth transceiver that offers up to 100 mW of output power. It has a noise figure of 5 dB. It provides 40 MHz of bandwidth capacity. WBX USRP2 has tremendous applications in the areas of ISM (Industrial, Scientific& Medical frequency band), land-mobile communications, maritime.

## 5. EXPERIMENTAL SETUP

In this paper, in the transmitter side a wbx-usrp2 is connected with the system in which the GNU Radio [3] software is installed. Then we have generated a monotone signal of frequency of 100kHz as shown in fig.4 by using signal source block which is available inside GNU Radio software and so the sampling rate is set 640KHz to satisfy the nyquist condition( $f_s \geq 2 f_m$ ).

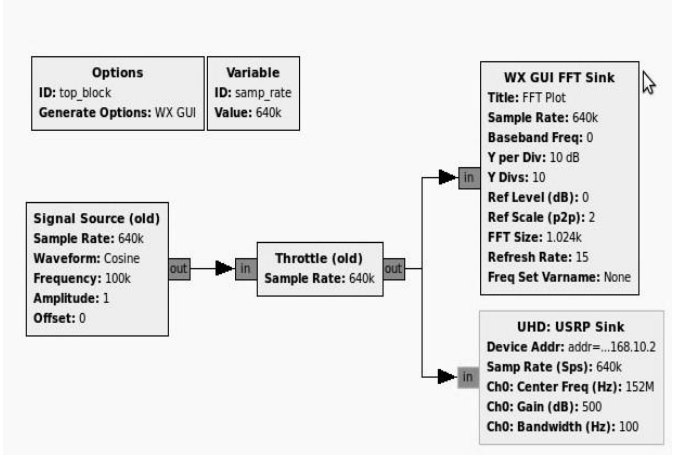


**Fig -2:** Transmitter block diagram

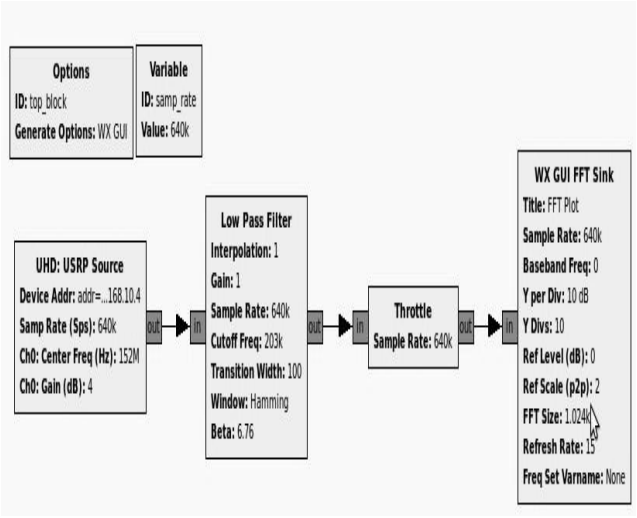


**Fig -3:** Receiver block diagram

The spectrum of transmitted signal is viewed by the block wx gui fft sink. The centre frequency of transmitter usrp2 is set 152MHz as per the antenna design (f=143/0.94m). In the receiver side, another wbx-usrp2 which in turn is connected to Yagi-Uda antenna to receive the transmitted signal as shown down in fig.5. We have taken gain measurements for each 10 degree angle by rotating Yagi-Uda antenna horizontally.

## 6. RESULT

To analyze the radiation pattern at different angles (0-360$^0$) a single tone frequency of 100kHz has been transmitted using USRP-2 and received the same signal at preferred centre frequency in addition with some noises**.** The noises emerged in the received signal lead to appear side lobes in the polar plot.

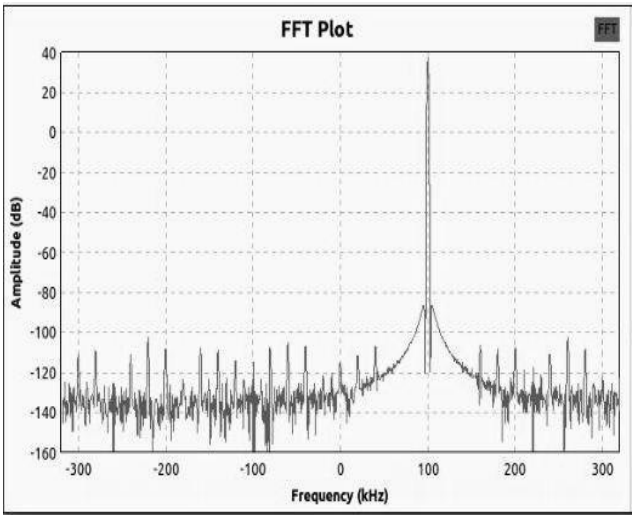


**Fig -4:** Transmitted input signal

To obtain antenna radiation pattern Antenna Radiation Diagram Plotter 1.0.3 toolkit is used. Manually readings of gain versus corresponding degree are taken and plotted using the given toolkit as shown in fig.6.

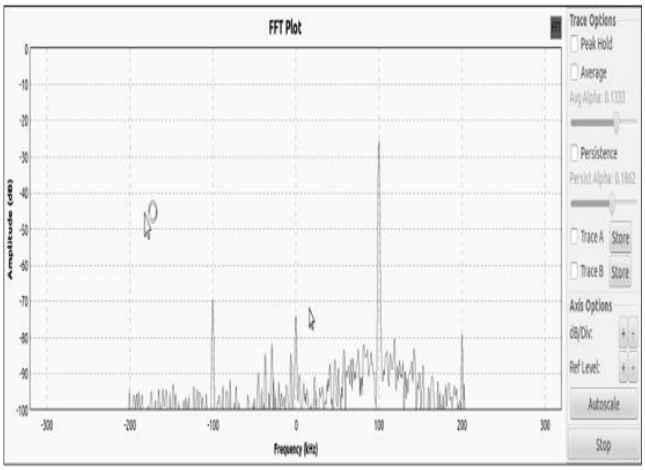


**Fig -5**: Received signal output

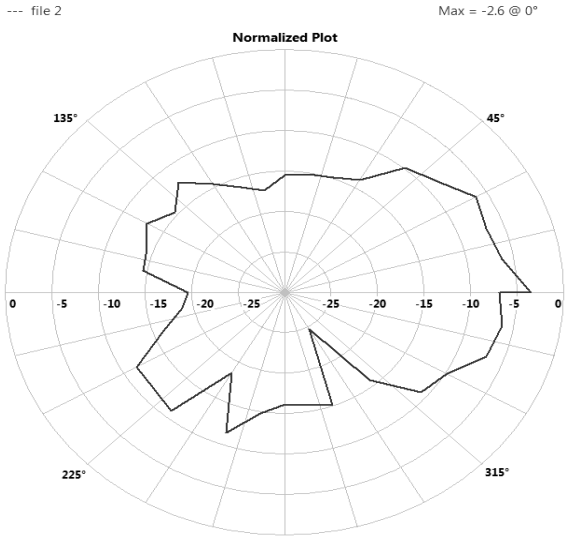


**Fig.6:** Measured radiation pattern of Yagi antenna

## 7. CONCLUSIONS

In this paper the radiation pattern measurement of a unidirectional Yagi-Uda antenna is carried through USRP2 in conjunction with GNU radio platform. The conventional radiation pattern methods of any antenna will be directed to change to this platform by the proposed method. It is a powerful tool established with USRP is used for testing as well as developing wireless applications such as MIMO, wireless transmission of JPEG files, Soft DVB-T and OFDM based applications at low cost for research as well as academic purposes.

## REFERENCES

[1] http://en.wikipedia.org/wiki/universalSoftware_Radio_Peripheral

[2] Ankit Agnihotri,Akshay Prabhu,Dheerendra Mishra,"Improvement in Radiation Pattern Of Yagi-Uda Antenna", Research Inventy:International Journal Of Engineering And Science.

[3] Sruthi M B,Abirami M, AkhilManikkoth, Gandhiraj R, Soman K P, "Low cost digital transceiver design for Software Defined Radio using RTL-SDR", IEEE International Multi Conference on Automation, Computing, Control, Communication and Compressed Sensing.

[4] Sachin Hirve, Saikrishna Gumudavally,Department of Electrical and Computer Engineering, Cleveland State University," Wireless transmission JPEG files using USRP with GNU Radio".

[5] http://gnuradio.org/redmine/projects/

[6] "ettus reasearch",http://ettus.com/Accesssed on Oct 2013.

[7] http://code.ettus.com/redmine/ettus/projects/uhd/wiki, Accesssed on Oct 2013

## BIOGRAPHIES

**Sreethivya M.** Currently doing Mtech Degree in Remote sensing and Wireless sensor Networks, Amrita Vishwa Vidyapeetham, Tamilnadu, India. Her current research interest are in image processing, Remote sensing Software Defined Radio.

**Dhanya M G.** Currently doing Mtech Degree in Remote sensing and Wireless sensor Networks, Amrita Vishwa Vidyapeetham, Tamilnadu, India. Her current research interest are in image processing, wireless networking, Software define Radio.

**Nimisha C.** Currently doing Mtech Degree in Computational Engineering and Networking, Amrita Vishwa Vidyapeetham, Tamilnadu, India. Her current research interest are in image. Processing, Software Defined Radio.

**Gandhiraj R.** Currently working as Assistant Professor in department of ECE, Amrita Vishwa Vidyapeetham, Tamilnadu, India. His current research interest are in Software Defined Radio, Wireless communication

**Dr. K P Soman** Currentlly working as HOD of CEN department, Amrita Vishwa Vidyapeetham, Tamilnadu, India. His current research interest are in Deep Learning, Cryptography, Linear Algebra,Software Defined Radio