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DESIGN & CHARACTERIZATION OF MULTIBAND YAGI- UDA RADIATOR

Gulshan Sharma, Vijay Sharma, and P.K. Singhal
gulshan087@gmail.com, chottu.vijay@gmail.com and pks_65@yahoo.com
Department of Electronics, Madhav Institute of Technology & Science, Gwalior (M.P.)-474005, INDIA

Abstract:

This paper presents a multi- frequency Yagi-Uda array radiator. Electromagnetic interference plays a significant role in radiation characteristics of a Yagi-Uda Antenna system. For this paper, two array of dipoles are fabricated on a single supported common feed boom and achieve the electromagnetic interference along the axis and perpendicular to the axis of the controlling boom (which is discussed in detail below). The Antenna potential characteristics such as return loss, radiation pattern and beam-width are taken in account for the analysis of proposed Antenna.

Keywords:
Antenna Beam-Width, Electromagnetic Interference, Radiation Pattern, Return Loss, Yagi-Uda Antenna.

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Introduction: An Antenna is a system of elevated conductors which matches the transmitter or receiver to free space[1]. The Yagi-Uda Antenna is a practical radiator in HF (3-30MHz), VHF (30-300MHz), and UHF (300-3000MHz) .The Yagi-Uda Antenna consist number of dipoles, which are arranged on a supporting or controlling boom, One of which is directly energized by the feeding transmission line called driver element and other elements acts like parasitic element. The current are induced in parasitic element by mutual coupling. The parasitic elements are responsible to improve the radiation pattern in forward direction [2].

Theory: A typical Yagi-Uda Antenna consist of three element one driven element, a reflector and one or more directors as discussed below.

1. Driven element

The driven element can be a simple dipole or a folded dipole. The driven element is only the active element in the whole structure of Yagi-Uda Antenna i.e. directly energized by transmission feed line and it is made up of two aligned conductors of length "λ/4" in which one in connected to shield of coax cable and other one connected to the signal. In order to achieve good resonance the total length of dipole should be "λ/2" i.e. half of the wavelength[3].

2. Directors

The directors are used to shape the Antenna beam. They are the parasitic element and excited by the field or EM coupling .

The spacing between the directors can affect the bandwidth of the Antenna as well as gain. For achieve the better gain equally spaced elements of equal length should be used [4].

3. Reflectors

The Yagi-Uda Antenna is viewed from left to right. The reflector is placed at the front side of the Yagi-Uda Antenna and its electrical length will be 5% longer than driven element. The reflector is used to cancels the backward wave arises due to the destructive interference[5].

Antenna design: Actually this is a prediction based work and also in the far field analysis of Yagi- Uda Antenna there is a superposition or interference of EM waves are happen generated by all the elements.

In direction of supporting boom there is a constructive interference is takes place which causes a major lobe but on the other half a destructive interference is arises in the perpendicular direction of boom that's why some minor lobes is happen in the radiation pattern of the antenna [6].

The main concept of achieving multiband characteristics through this antenna is to use of electromagnetic interference in both the direction of single supported but not purely isolated boom(just because of hollow shape)[7,8,9].

Although, there were no simple formulae to design the Yagi-Uda Antenna, while NBS(National Bureau of Standards see in NBS Notes 688) defines some specifications to design Yagi-Uda Antenna[10,11,12,13].

For this work, two Yagi-Uda Antennas are fabricated on a single supporting boom at different frequencies i.e. 1GHz and 2GHz and aligned perpendicularly with each other (as shown in figure 1). As saw from front view 16-element Yagi-Uda Antenna at 2GHz is shown at the front and another Yagi-Uda Antenna at 1GHz with 3-element is shown at the top of the struture as shown in figure 1 (b), and this 1GHz Yagi-Uda Antenna is situated between the 16-element (as shown). A BNC feed is use to excite the whole structure, and the noticeable thing is that both the Antennas are excited at the same time with the common feed.

1(a)

1(b)

Figure 1: A typical view of Proposed Yagi-Uda Antenna (Front and Top View).

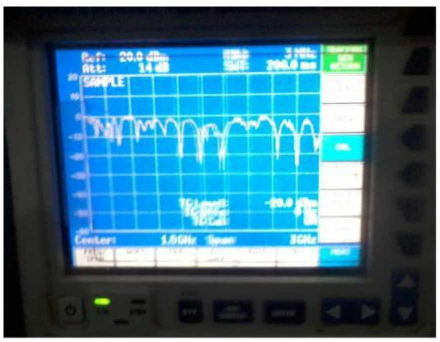
Fabrication: The fabrication of proposed multiband Yagi-Uda Antenna contains the following hardware material[13,14,15]-

- A ½ inches PVC contour hollow pipe is use for providing the supporting boom to whole structure of proposed antenna.
- Now, 0.8mm diameter metal (iron) rod is use to construct the Antenna element.
- These elements are fixed in boom by hot glue or M-seal.
- A common BNC feed is use to excited the Antenna which is connected with both the driven element of both the Antenna.

Measurement: There are three antenna potential characteristics are taken in account for the analysis of proposed antenna as discussed below:

1. **Return loss Measurement:** The return loss measurement has been done by the FS-315 spectrum analyzer, connected with SWR bridge and proposed Antenna. The typical measurement set up is shown in the figure 2.All the measured values are taken at minimum hold condition of spectrum analyzer for accurate measurement.

(a)



(b)

Figure 2: Set-up use for measurement.

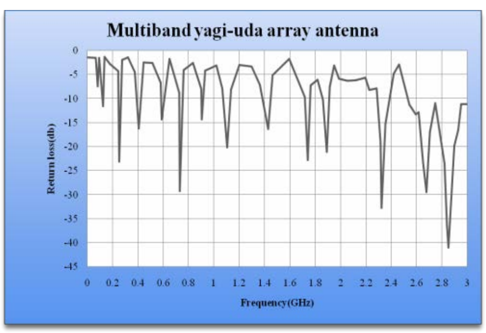


Figure 3: Return loss chracteristics of proposed Antenna.

2. **Radiation Pattern Measurement:** The radiation pattern of proposed Yagi-Uda Antenna(shown in figure 4), is achieved at 1 GHz and to generate the signal of 1 GHz an printed Archimedean spiral antenna have been used which is situated at the transmitting end, and connected to the signal generator.

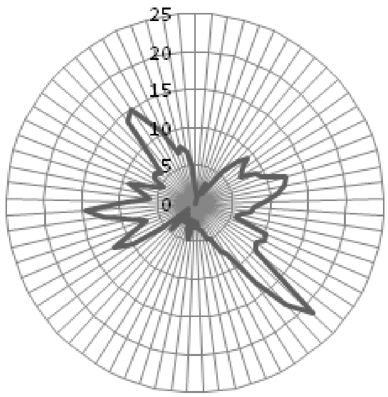


Figure 4: Radiation pattern of proposed Antenna.

3. Gain measurement:

Although the theoritical gain of the proposed antenna is about 25-27 db but the measured gain is 23.56 db just because of standard or reference gain antenna. For here a microstrip patch antenna with 2.45 db gain is used as a referene gain antenna and the gain of the antenna under test is given by:

Gain (dBi) = Reference Gain+ (Measured Level - Reference Level)

Results and observation:

- As far as the return loss of proposed Antenna is concerned it falls 14 times below 10db which shows that the proposed Antenna works at these all resonant frequencies and works as a multiband radiator, also gives bandwidth approx 50MHz between 2.5-3 GHz(as shown in figure).
- Or on the other half, the radiation pattern shows directionality (as shown in figure) with small beamwidth, this is arises just because of arrangement of proposed Antenna (because EM waves are superimpose to each other).

Conclusion: From all the analysis of the proposed Antenna, this paper covers the desirable multiband response and as far as the radiation pattern of proposed Antenna is concerned it shows some directionality which is nearest to Omni-directional pattern.

In future, this work could be done from different length of Antenna element with different metal and gives better results in this direction.

References:

1. C.A.Balanies"Antenna theory analysis and design" 2nd edition,Jhon wiley and sons,NewYork,997.

2. Modified two Element Yagi-Uda Antenna with tunable beams-B.-H.Sun,Y.-F.Wei and Q.-Z Liu,Progress in Electromegnatic research,PIER-100,175-187,2010.

3. Security of wireless networks, Antennas Exercise, Thomas Fahrni and Andreas, Miller, Dec.6, 2009.

4. A novel wide band Microstrip Yagi-Uda array Antenna for WLAN applications-M. Bemani and S. Nikmehr, Progress in Electromegnatic research, vol.16, 389-406, 2009.

5. Dual band Yagi-Uda Antenna for wireless communication-Q. Xin,F.-S.Zhang, B.H.Sun,Y.l-Zou,and Q.-Z.Liu, Progress in Electromegnatic research,vol.16,119-129,2010.

6. Yagi-Uda Antenna,Rechard Laugesen,Phys-Electromegnatic application.

7. Design of Yagi-Uda Antenna at 435MHz for Indian MST Radar,R.P.Labade,Dr.S.B.Deosarkar.

8. Kraus: J.D and R.J Marhefka Antennas: for all applications, 3rd edition, 803-825, MxgrawHill companies, INC, 2002.

9. Ronghong J. and X. Huang, **"**A Conformal Archimedean Spiral", Antenna for Ultrawide-band Systems. Progress in Electromagnetics Research Symposium 2005, Hangzhou August 23-26.

10. Q. Liu, C.-L. Ruan, L. Peng, and W.-X. Wu, "A Novel Compact Archimedean Spiral Antenna With Gap-Loading", Progress in Electromagnetics Research Letters, Vol. 3, 169–177, 2008

11. W.D. Rawle and Aerospace S., "The Method of Moments: A Numerical Technique for Wire Antenna Design", high frequency electronics, Feb-2006.

12. Emerson, D., AA7FV, "The Gain of the Axial-Mode Helix Antenna", Antenna Compendium Volume 4, ARRL, 1995, pp. 64-68.

13. Zaker, R., Ch. Ghobadi, and J. Nourinia, "A modified microstrip-fed two-step tapered monopole Antenna for UWB and WLANapplications", Progress in

Electromegnatics research, PIER 77,137–148, 2007.

14. Bemani and S. Nikmehr, “A novel wide band Microstrip Yagi-Uda array Antenna for WLAN –M”, Progress in Electromegnatics research, vol.16, 389-406, 2009.

15. Q. Xin,F.-S.Zhang,B.H.Sun,Y.l-Zou,and Q.-Z Liu, “Dual band Yagi-Uda Antenna for wireless communication”, Progress in Electromegnatics research,vol.16,119-129, 2010.