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A Review on Neoteric Blade antenna for Airborne Applications

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Abstract: ***Antenna is a specialized transducer to transmit and receive electromagnetic signals. it is an important part of any wireless communication system which is an original detection device for the detection of electromagnetic waves in long-wave frequency band. Now a days, most communication systems require antennas with features like compact size, aerodynamically suitable and light weight. This paper proposes about simple monopole blade antenna used in airborne applications, telemetry navigation transponders etc. This blade antenna is Anticipated for high bird snapper in the sky and operated at frequencies 0.5 to 2 GHz range.***

I.INTRODUCTION

An antenna is a metallic object which converts electrical signals into radio waves and vice versa. Antenna can also be termed as aerial. It is usually used with radar systems that direct incoming and outgoing radio waves. Many types of antennas have been developed for different purposes. An antenna may be designed specifically to transmit or to receive, In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves).

Transmitting Antenna:

In general, must be able to handle much more electrical energy than a receiving antenna. An antenna also may be designed to transmit at specific frequencies. Frequency modulation (FM) broadcasting, on the other hand, is carried out at a range from 88 to 108 megahertz (MHz). At these frequencies a typical wavelength is about 3 meters (10 feet) long, and the antenna must be adjusted more precisely to the electromagnetic wave, both in transmitting and in receiving. Antennas may consist of single lengths of wire or rods in various shapes (dipole, loop, and helical antennas), or of more elaborate arrangements of elements (linear, planar, or electronically steerable arrays). Reflectors and lens antennas use a parabolic dish to collect and focus the energy of radio waves, in much the same way that a parabolic mirror in a reflecting telescope collects light rays. Directional antennas are designed to be aimed directly at the signal source and are used in direction-finding.

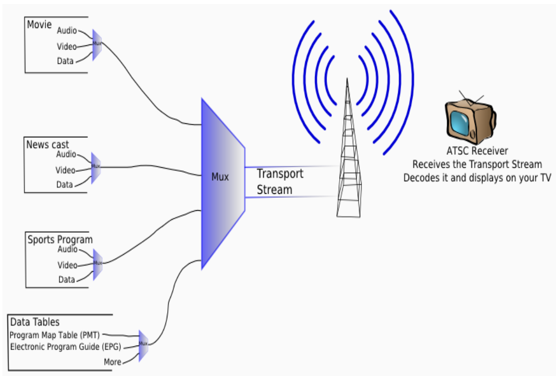

Fig1:Transport stream

Receiving Antenna:

An antenna used to convert electromagnetic waves to modulated radio frequency currents is called receiving antenna. The antennas are used simply to radiate electromagnetic energy in an Omni directional or finally in some systems for point-to-point communication purpose in which increased gain and reduced wave interference are required. Receiving loop antenna for top band allows reducing noise on both bands. A knowledge of the current I(0) and the input impedance Z0, completely determines the receiving characteristics of the antenna

Radiation Principle:

Radiation is the net outward flow of electromagnetic energy from the source. Radiated power is carried by free space waves with electromagnetic fields detached from the source. After an RF signal has been generated in a transmitter, some means must be used to radiate this signal through space to a receiver. The transmitter signal energy is sent into space by a transmitting antenna. The RF signal is then picked up from space by a receiving antenna. The rf energy is transmitted into space in the form of an electromagnetic field. As the travelling electromagnetic field arrives at the receiving antenna, a voltage is induced into the antenna (a conductor).The rf voltages induced into the receiving antenna are then passed into the receiver and converted back into the transmitted rf information. The design of the antenna system is very important in a transmitting station. The antenna must be able to radiate efficiently so the power supplied by the transmitter is not wasted. The dimensions are determined by the transmitting frequencies. The dimensions of the receiving antenna are not critical for relatively low radio frequencies. However, as the frequency of the signal being received increases, the design and installation of the receiving antenna become more critical.

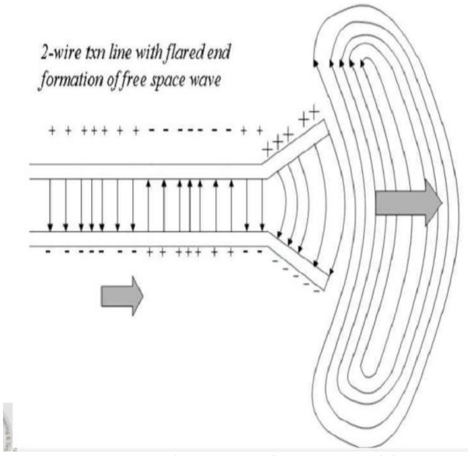

Fig2:2-wire txn line with flared end formation of free space wave

When ac. signal is applied to the line from source time varying electric and magnetic fields are created. The creation of time varying electric and magnetic fields between the conductors form electromagnetic waves which travel along the transmission line as shown in Fig. The Electromagnetic waves enter the antenna and have associated with them electric charges and corresponding currents.

Antenna Classification :

Antennas are classified based on the radiation pattern of the feeding mechanism. antenna radiation pattern is the angular variation of signal strength around the antenna. feeding mechanism defines the how the signal is fed into the antenna and the location of the feed point of the antenna

1 Frequency - VLF, LF, HF, VHF, UHF, Microwave, Millimeter wave antenna

2 Aperture - Wire, Parabolic Dish, Microstrip Patch antenna

3. Polarization - Linear (Vertical/Horizontal), Circular polarization antenna

4. Radiation - Isotropic, Omnidirectional, Directional, Hemispherical antenna

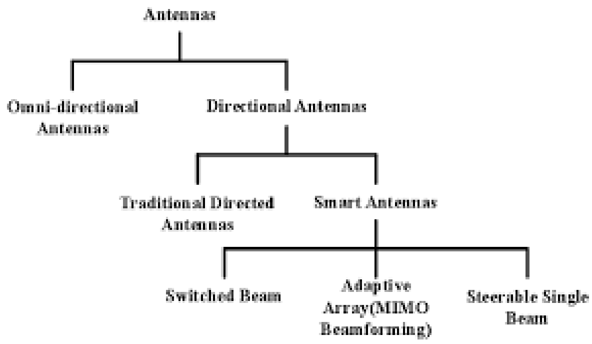

Fig3: Classification of antennas

Antenna Classification on Polarization Basis:

Antenna polarization is governed by the polarization of Electromagnetic waves. Based on that:

1. Linearly (Vertically/Horizontally) Polarized antenna.
2. Circularly Polarized antenna. (Vertically/Horizontally) polarized antenna

Linear polarisation antenna:

a plane electromagnetic wave is said to be linearly polarized. The transverse electric field wave is accompanied by a magnetic field. With linear polarization the electric field vector stays in the same plane.

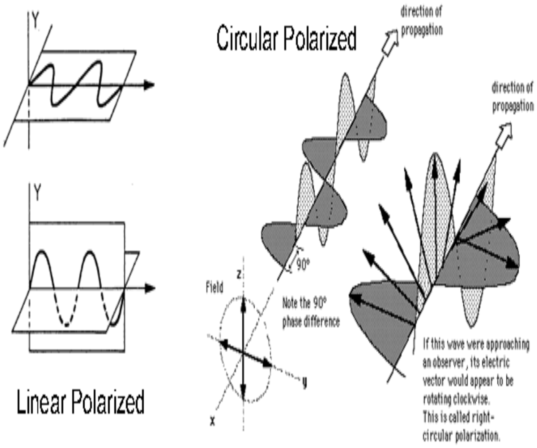

Fig4: Linear vs circular polarized antennas

Circular polarisation antenna:

Circular polarized light consists of two perpendicular electromagnetic plane waves of equal amplitude and 90 degrees difference in phase.

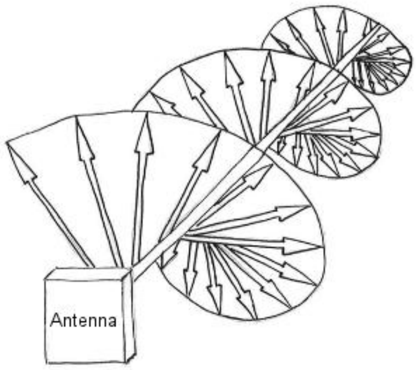

Fig5: Circular vs linear polarised antennas.

II. BLADE ANTENNA - PROPOSED WORK

Blade monopole antennas are especially interesting due to their flat easy to fabricate, wind resistant characteristics due to their thin structures, they can be easily machined and fabricated on RF substrates. Blade antennas are variously used in airborne applications. Planar monopoles tend to be suitable candidate for their appealing physical features as well as interesting response and design versatility. Requirements posed on an antenna to be considered suitable for a wideband application are not only the impedance bandwidth with low VSWR and radiation pattern stability over the desired band but also linear phase response and optimum radiation efficiency. Narrow band monopole antenna can be transformed into broadband antenna either by

i. Lower length to diameter ratio (L/D).
ii. Following the angular concept of Rumsey's criteria
iii. Using broadband matching circuits.

Such broadband antennas cater for data and voice communication, multimedia, surveillance, telemetry applications. The conventional bi conical or disc one antenna can easily cover the required proposed bandwidth, but they are large in size and bulky, thus make them not suitable for airborne applications. In this paper, the design and development of broad band blade shaped monopole antenna was evaluated for its performance using a metallic circular ground plane of 1.2mdiameter. The VSWR of the antenna was measured using R&S ZVRE Vector Network Analyzer and was found to be less than 2.5: lower the frequency band 0.5-1.5 GHz. Fig.2 shows the comparison plot of simulated and measured VSWR which are in close agreement.

Design and Implementation:

The proposed broadband blade monopole antenna is print edon the RT Duriod 5880TM substrate having dielectric constant ,εr=2.2. The thickness of the substrate is 1.6mm.

The space between the Printed Card and the radome was filled with syntactic foam. The whole antenna assembly is a single integral structure encompassing the printed monopole antenna, base plate and radome type of realization increases the strength of the antenna for withstanding the environmental severities like vibration, air drag, rain etc.,. The photograph of developed antenna is shown in fig. 1.

Fig6: Blade antenna

The overall antenna dimensions are 113 mm(Length) x 140 mm (Width) x 50 mm (Thickness). The antenna dimensions in terms of wavelength at lowest frequency of operation are 0.19A x 0.23A x 0.08A. The antenna was fed at the base of the radiator with N-type receptacle. The E-plane patterns exhibit maxima at elevation angles varying from 15° to 30° above the horizon. Normalized simulated and measured radiation patterns at 0.5GHz, 1.0GHz and1.5GHz for both azimuth and elevation planes From the patterns it is observed that the drop in the gain from the maxima to the gain at horizon varies from 4 to 6 dB over the frequency. From these plots it is observed that the simulated and measured radiation patterns are very similar. The minor deviations can be attributed to the free space environment assumed for simulation. The gain of the antenna was measured and to vary from 4 to 8dbi.

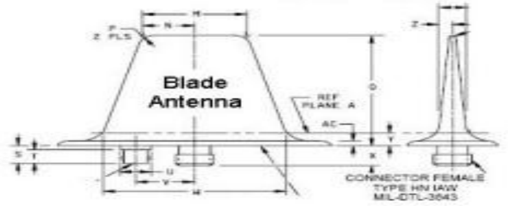

Fig 7:measurement of blade antenna

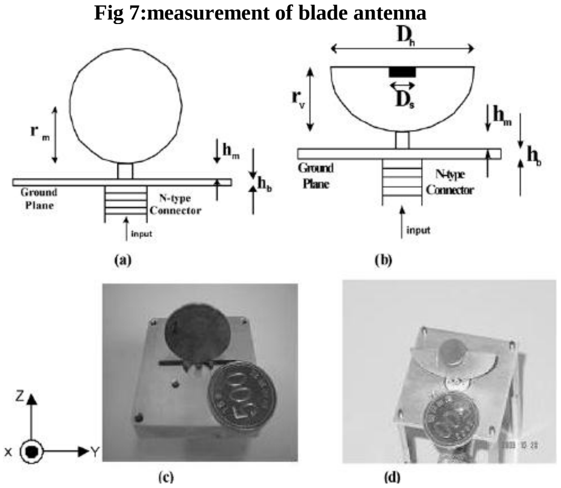

Fig8: Disc loaded monopole antennas

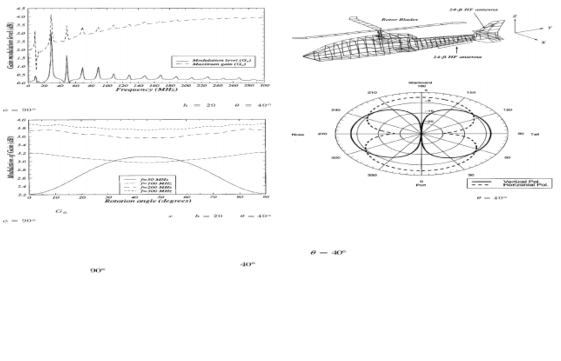

Fig9: Helicopter rotor blade modulation of antenna radiation characteristics 693

the maximum frequency in the operating bandwidth of the antenna is 600 MHz due to the constraints on the radiation pattern. In blade antennas, the direction of the maximum gain elevates as the frequency increases. The optimized blade antenna with one oblique edge is fabricated by aluminium plates with thickness of 2 mm

III. RESULTS

Radiation Pattern:

A radiation pattern defines the variations of the power supply radiated by an antenna as a function of direction away from the antenna.This power variation as a function of the arrival angle is observed in the antennas far field.

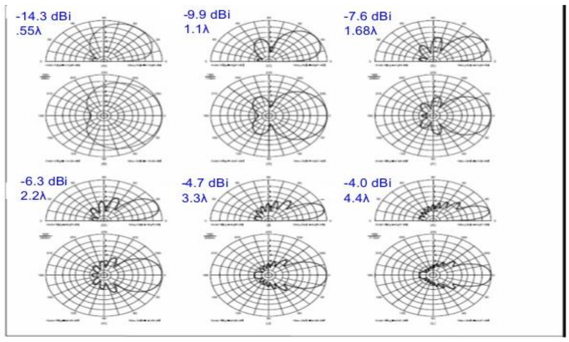

Fig10 : Radiation patterns per length

Properties of Radiation Pattern of antenna:

• Always measured in Far field.D2

Far field: r 2 largest dimension of the antenna.

• Field intensity decreases with increasing distance, as1/r .

• Radiated power density decreases as 1/r2.

• Pattern (shape) independent on distance.

• Usually shown only in principal planes.

Antenna Regions:

With a high frequency current flows in an antenna. it generates a high frequency electromagnetic field in the surrounding space . The near field and far field are regions of the electromagnetic field around an object, such as a transmitting antenna, or the result of radiation scattering off an object. Non-radiative 'near-field' behaviors of electromagnetic fields dominate close to the antenna or scattering object, while electromagnetic radiation 'far-field' behaviors dominate at greater distances. Far-field E and B field strength decreases inversely with distance from the source, resulting in an inverse-square law for the radiated power intensity of electromagnetic radiation.

– Gain is not a meaningful parameter here

– E and H are not equal

– Reactive components 10% or more of radiating components may cause error in field measurements.

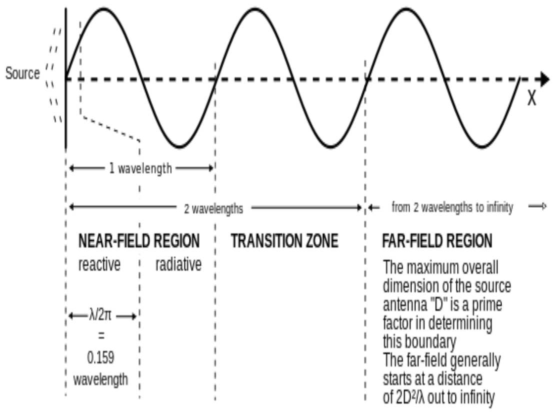

Fig11: field regions of antenna

Gain (G): Antenna gain is usually defined as the ratio of the power produced by the antenna from a far-field source on the antenna's beam axis to the power produced by a hypothetical lossless isotropic antenna, which is equally sensitive to signals from all directions. Usually this ratio is expressed in decibels, and these units are referred to as "decibels isotropic" (dBi). An alternative definition compares the antenna to the power received by a lossless half-wave dipole antenna, in which case the units are written as dbd. Since a lossless dipole antenna has a gain of 2.15 dBi, the relation between these units is: gain in dbd =gain in dbi− 2.15. For a given frequency, the antenna's effective area is proportional to the power gain. An antenna's effective length is proportional to the square root of the antenna's gain for a particular frequency and radiation resistance. Due to reciprocity, the gain of any antenna when receiving is equal to its gain when transmitting.

Directivity (D):

Directivity of an antenna is defined as the ratio of Maximum radiation intensity to its average radiation intensity. Relation between Directivity and Gain of antenna-G ç D where ç – efficiency of the antenna

Antenna Efficiency (ç):

Antenna efficiency is defined as the ratio of the aperture effective area, A_e to its actual physical area, A. It describes the percentage of the physical aperture area which actually captures radio frequency (RF) energy. Thus, the effective area of an aperture antenna is the surface area of a theoretically perfect aperture that would collect the same energy as the actual aperture with associated antenna

Efficiency. $\mathbf{A_e=A_n}$

Polarization:

The polarization of an antenna defines the orientation of the E and H waves transmitted or received by the antenna. Linear polarization includes vertical, horizontal or slant (any angle)Typical non-linear includes right- and left-hand circular (also elliptical) Polarization is an important parameter in areas of science dealing with transverse wave propagation, such as optics, seismology, radio, and microwaves.
Especially impacted are technologies such as lasers, wireless and optical fibre telecommunications, and radar.

VSWR/Return loss:

VSWR or Return Loss determines the matching properties of antenna. It indicates that how much efficiently antenna is transmitting/receiving electromagnetic wave over particular band of frequencies.

Impedance:

Antenna must be terminating with 50 Ohm impedance in order to transfer maximum power from transmitter into free space.

Antenna Measurement:

Antenna Measurement techniques refers to the testing of antennas to ensure that the antenna meets specifications or simply to characterize it. Typical parameters of antennas are gain, radiation pattern, beam width, polarization, and impedance.

1. Passive Measurement
• VSWR/Return Loss
• Impedance Bandwidth
2. Active Measurement
•Radiation Pattern (Elevation and Azimuth)
• Gain
• Directivity
• Half Power Beam width
• Cross Polarization

Digital processing requires that the signal from each antenna element is digitized using an A/D converter. Since radio signals above shortwave frequencies (>30 MHz) are too high to be directly digitized at a reasonable cost, digital beam forming receivers use analog "RF translators" to shift the signal frequency down before the A/D converters.

Applications:

- Data Links, Telemetry, Transponder
- Aircraft
- UAVs
- Helicopters
- Tactical Missiles
- Ships

- Ground-Based Vehicles
- Single or Array Implementations with Matching Power Dividers and Cables

IV. CONCLUSION

The description about blade antenna and its characteristics is explained in this paper is explained in detail. The design considerations of the blade antenna are mentioned with suitable diagrams and equations. such designed blade antenna is simulated by using mentor graphics IE3D tool.

References

[1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955. (*references*)

[2] Constantine A. Balanis, fellow, IEEE Invited PaperAntenna Theory – A review

[3] J. C. Maxwell, A Treatise on Electricity und Magnetism. London, U.K.: Oxford Univ. Press, 1873, 1904.

[4] S. Silver, Ed., Microwave Antenna Theory and Design. MIT Radiation Lab. Series, vol. 12. New York: McGraw-Hill, 1949.

[5] W. Stutzman, "Bibliography for antennas," IEEE Antennas Propagat. Mag., vol. 32, pp. 54-57, Aug. 1990.

[6] Philippe Pouliguen, Lionel Lucas: Calculation and Analysis of Electromagnetic Scattering by Helicaopter Rotating Blades, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 50, NO. 10, OCTOBER 2002.

[7] James E. Richie, Senior Member, IEEE, and Benjamin R. Koch, Member, "The Use of Side-Mounted Loop Antennas on Platforms to Obtain Nearly Omnidirectional Radiation"IEEE, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 53, NO. 12, DECEMBER 2005

[8] L. Mattioni and G. Marrocco "BLADE: A Broadband Loaded Antenna Designer" IEEE Antennas and Propagation Magazine, Vol. 48, No. 5, October 2006

[9] Marta Cabedo-Fabres, Eva Antonino-Daviu, Alejandro Valero-Nogueira and Miguel FerrandoBataller"The Theory of Characteristic Modes Revisited: A Contribution to the Design of Antennas for Modern Applications" IEEEAntennas and Propagation Magazine, Vol. 49, No. 5, October 2007

[10] Andrew R. Weily, Member, IEEE, Trevor S. Bird, Fellow, IEEE, and Y. Jay Guo, Senior Member, IEEE "A Reconfigurable High-Gain Partially Reflecting Surface Antenna" 0018-926X/$25.00 © 2008 IEEE

[11] Javier Leonardo AraqueQuijano and Giuseppe Vecchi,, "Optimization of an Innovative Type of Compact Frequency-Reconfigurable Antenna" IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 57, NO. 1, JANUARY 2009

[12] Emrah ÖNCÜ "Single Stub Tuning Application via Semi-Rigid Coaxial Cables for VHF and UHF Monopole Antennas on RASAT", 978-1-4244-7243-7/10/$26.00 ©IEEE, 2010.

[13] [13]Xiaoyan Yuan, Zhouyuan Li, Daniel Rodrigo, "A Parasitic Layer-Based Reconfigurable Antenna Design by Multi-Objective Optimization", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 60, NO. 6, JUNE 2012.

[14] Hai Lu1 , Xiaotong Sun2 , Mark S. Bolding3 , C. J. Reddy4 , and Shumin Wang1" Fast Prototyping of Near-Field Antennas for Magnetic Resonance Imaging by Using MoM Simulations and 3-D Printing Technology", IEEE Antennas and Propagation Magazine, Vol. 57, No. 2, April 2015

[15] I. A. Baratta and C. B. Andrade,Installed Performance Assessment of Blade Antenna by Means of the Infinitesimal Dipole Model" IEEE LATIN AMERICA TRANSACTIONS, VOL. 14, NO. 2, FEB. 2016

[16] Zill-e-Tooba1,Hasan Raza2, HibaHussain Mashhadi3, Asaf Khan4 , Design and fabrication of broadband planar monopole antenna operating in 1.2-6 GHz band, 978-1-4673-9127-6/16/$31.00 © IEEE 2015.

[17] Tariq Rahim1, Arshad Wahab1 and Jiadong Xu1,"Open ended dielectric filled slot blade antenna design with coaxial feed for airborne applications" IET, 978-1-78561-038-7, Hangzhou, 14-16 Oct. 2015.

[18] QiWu, Evaluation of Isolation between Blade Antennas in Pre-design Phase using a Synthesized Model, 978-1-4673-9494-9116/$31.0 © IEEE,20 16.

[19] João T. Costa, Rodrigo K. Enjiu, "Efficient 3D EM Simulation of Antennas Mounted on Electrically Large Bodies" 978-1-4673-9492-5/15/$31.00© 20 15 IEEE.

[20] MeliksahYayan, OnurhanDuman," Directional Blade Antenna with Increased Sectoral Gain" 978-1-4799-7815-1/15/$31.00 ©IEEE 2015.

[21] BijanAbbasiArand, et al. "Design and Fabrication of a Broadband Blade Monopole Antenna Operating in 30 MHz – 600 MHz Frequency Band" 978-1-4673-5634-3/13/$31.00 © IEEE 2013.

[22] ChandanaSairam, TakeshoreKhumanthem, ShukdasAhirwar, Sheilu Singh, Broadband Blade Antenna for Airborne Applications, 978-1-4577-1110-7, Annual IEEE India Conference 2011 .

[23] K. Prasad1, B. Lakshmi Devi 2 "Design and Simulation of Wide-Band Square Microstrip Patch Antenna" International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 7, pp. 457-460, July 2016.

[24] K.Prasad, S.Muneera Begum, "Novel Approach to the design and simulation of square spiral antenna" ISSN:2455-1341, International Journel of Research in Engineering Technology, IJRET, volume 1 issue 5, pp: 6-10, 2016

[25] Blade antenna/ images/ google https: //www.google.co.in/search?

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