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Performance Evaluation of Antenna for Air and Water Applications

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ABSTRACT: Increased earth exploration has motivated the event of latest underwater communication systems. This growing interest can largely be attributed to new civil and military applications enabled by large-scale networks of underwater devices such as underwater static sensors, unmanned autonomous vehicles (AUVs), and autonomous robots, for retrieving information from the aquatic and marine environment, perform in-network processing on the extracted data, and transmit the collected information to remote locations. All natural waters contain some dissolved salts like sodium, magnesium and calcium. Sodium chloride (table salt) is the most common of all the salts; it is the main constituent of seawater..The attenuation due to the conductivity of seawater limits the effectiveness of electromagnetic underwater systems. Transmission frequencies and therefore the antenna design are examined during this paper with the goal of improving underwater communications. The performance of three antennas, specifically, Dipole, yagi uda and J-pole is assessed through simulation for usage in air and sea water operating in the High Frequency (HF) band. The antennas were designed in High Frequency Structure Simulator(HFSS) and their performance is assessed in terms of bandwidth and directivity. The results obtained shows that the J-pole antenna has significant advantages in term of the measured parameters over the other antennas. Experimental results of the reflection coefficient of J-pole antenna in water are as long as agree well with the simulation results.

KEYWORDS: Autonomous underwater vehicle, Dipole Antennas, Yagi Uda Antennas, J-pole Antennas, directivity, bandwidth.

I. INTRODUCTION

There are three established technologies through which underwater communications have been considered, they are; acoustics and ultrasonic signals, optical signals, and Electromagnetic (EM) signals [1]. Each of these technologies has its merits and demerits in their usage for underwater communications. For instance, acoustic and ultrasonic systems are typically good for long range communications (up to tens of kilometers), but this technology is unfit for real time and broadband underwater wireless sensor networks due to poor immunity to noise, low data-rates and high channel latency [2]. Optical communication systems on the other hand deliver high data-rates and low latency, which are major advantages over acoustic systems, but at the same time it requires very good alignment and are also affected by suspended particles in water and marine fouling[2].Electromagnetic wave can only travel in water with short distance, high attenuation and absorption effect in underwater environment. The absorption of electromagnetic energy in sea water is about 45× f dB per kilometer, where f is frequency in Hertz. C.Nagarajan *et al.*[2,5,10] has proposed the digital era we've become conversant in the advantages of short-range, high-bandwidth communications systems. the oil industry and military operations have changing requirements that have created demand for reliable, connector less short-range data links. High permittivity and electrical conductivity of water gives a different form of electromagnetic propagation in water from that propagation through air.

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With a relative permittivity of 80, water features among the very best permittivity of any material and this has a significant impact on the angle of refraction at the air/water interface. Conductivity of seawater is usually around 4S/m, while nominally 'fresh' water conductivity is sort of variable but typically within the mS/m range. The attenuation of EM signals in sea water is higher than the fresh water

Relative permeability is approximately 1, so there's little direct effect on the magnetic flux component. Loss is essentially thanks to the effect of conduction on the electrical field component. Propagating waves provides cycle energy between magnetic fields and the electrical. Therefore during conduction electromagnetic wave propagation results in strong attenuation.

II. DESIGN OF ANTENNAS USING HFSS

A) Dipole Antenna

The dipole is that the most effective class of antenna in radio and telecommunication field. The dipole antenna whose radiation pattern produced is approximately equal to a radiating structure which is having an elementary structure. Generally, a dipole antenna consists of two conductors which are half waved dipole. The designed antenna is surrounded with the air box which is cylindrical in shape.. In the simulation results of dipole antenna the S parameters are used to identify the frequency loss which is lowered down at 1GHz. The 2D graph illustrating the S parameter values are shown in the below figure Fig.1.

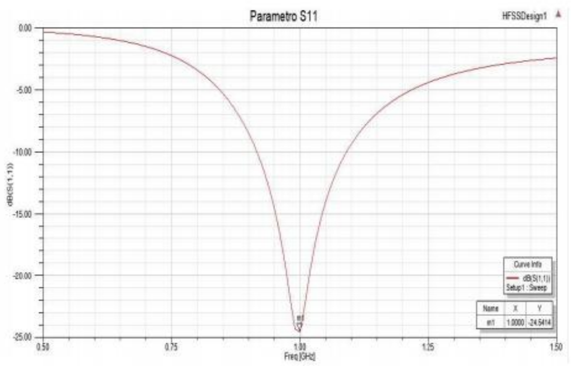

FIG 1 : Frequency vs GAIN

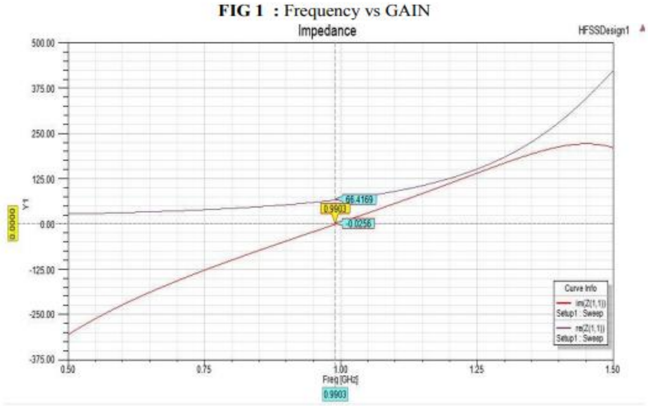

Fig.1 Impedance of Dipole Antenna

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B) Yagi uda Antenna

The most luminous antenna design is yagi-uda antenna. It *is constructed with a high gain, greater than 12 dB*. Normally it operates in the HF to UHF bands about 3 MHz to 3 GHz. The frequency range of s-parameter is 10.8 GHz and the return loss is -36.43 dB. The yagi-uda design of VSWR is 0.2938.The main goal of this design is to reduce the loss and also improve the efficiency.

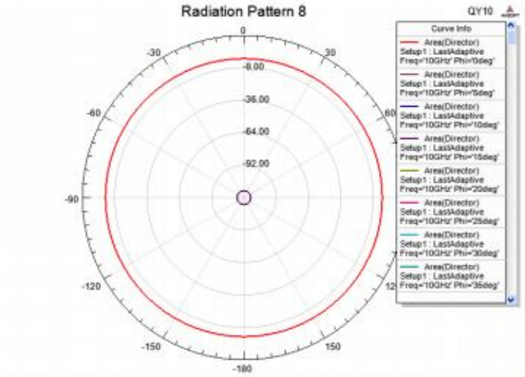

Fig2: Radiation Pattern of Yagi uda Antenna by HFSS tool

C) J-pole antenna

The J-pole antenna may be a half-wave vertical element end-fed by 1 / 4 wave matching stub; consisting of a half wavelength arm connected to 1 / 4 wavelength feed pair. [3] The lower end of the matching stub may be grounded directly. The J pole antenna is an Omni antenna . Matching to the feed-line is obtained by sliding the connection of the feed-line back and forth along the stub to get the voltage wave stationary wave Ratio is as close as possible to 1:1 [4]. The operation of J-pole is assumed to be that; the highest ½ wavelength section is that the radiation portion of the antenna, while the lower ¼ wavelength stub is employed for matching purpose and doesn’t radiate. But, this assumption is not entirely correct. If the assumption that; only the top ½ wavelength potion of J-pole radiates, then there wouldn't be any difference between the field patterns of J-pole and ½ wave dipole. For negligible radiation to take place from the ¼ wave matching stub, certain conditions prevail. First, the spacing between the two parallel conductors must be very close in terms of wavelength. Second, the currents in each conductor should be out of phase by 1800. The open end of the stub exhibits infinite impedance as no current exhibits at that time. Consequently, the present amplitudes between the parallel lines of the matching stub will not be equal [5]

Designing a J-Pole antenna differs from that of the standard dipole, because it consists of a parallel element attached to the most radiator. The main radiators electrical length is of $3\lambda/2$; the length of parallel arm is of $\lambda/4$. Its design of the radiator consist of a main radiator and its parallel element.

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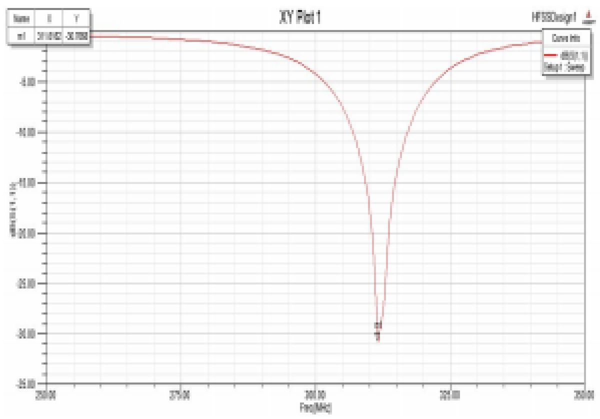

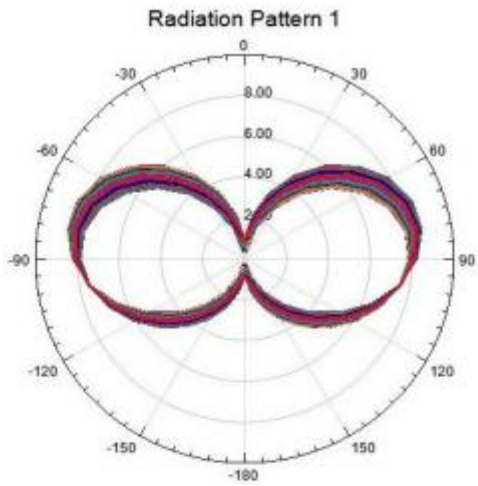

Fig.3 a) Return loss of J-Pole antenna. b) Azimuthal pattern of J-pole antenna.

III. PERFORMANCE EVALUATION

Network analyzers commonly measure s–parameters because reflection and transmission of electrical networks are easy to live at high frequencies. The length of those cables introduce a time delay and respective phase shift , thus affecting VNA measurement.

IV. EXPERIMENTAL RESULTS

TABLE I Simulation Results of the Antennas in Fresh Water

S /No.	Parameters	Dipole	Yagi Uda	J-Pole
1	Bandwidth (MHz)	12.84	20.4	26.41
2	Directivity (dB)	2.22	6.13	7.69
3	Impedance(Ohm)	19.40	21	-

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TABLE II Simulation Results of the Antennas in Sea Water

S /No.	Parameters	Dipole	Yagi Uda	J-Pole
1	Bandwidth (MHz	11.89	11.12	10.43
2	Directivity (dB)	3.61	5.1	7.69
3	Impedance (Ohm)	6.69	6.51	6.36

Table III Simulation Results of the Antennas in Air

S /No.		Dipole	Yagi Uda	J-Pole
1	Bandwidth (MHz	24.88	23.12	22.46
2	Directivity (dB)	3.86	6.45	7.31
3	Impedance (Ohm)	16.12	12.89	13.51

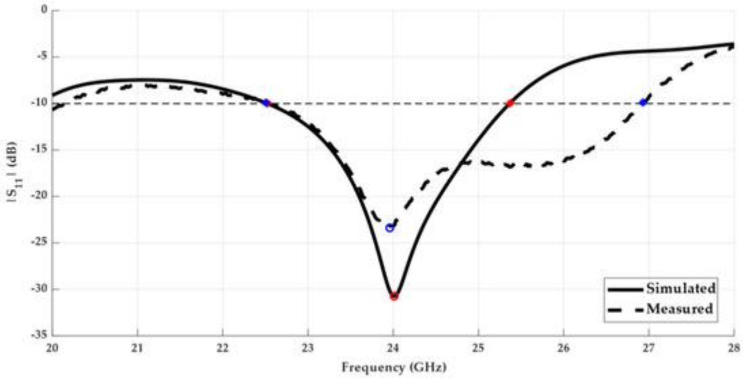

Fig.4 Simulated and measured reflection coefficient of dipole antenna.

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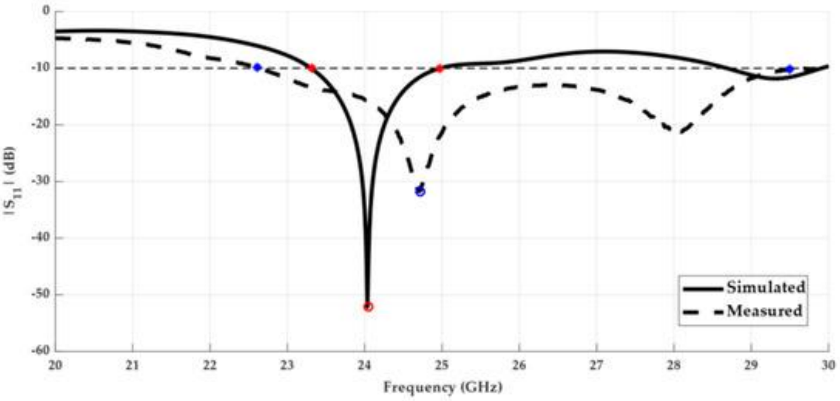

Fig. 5. Simulated and measured reflection coefficient of the Yagi antenna.

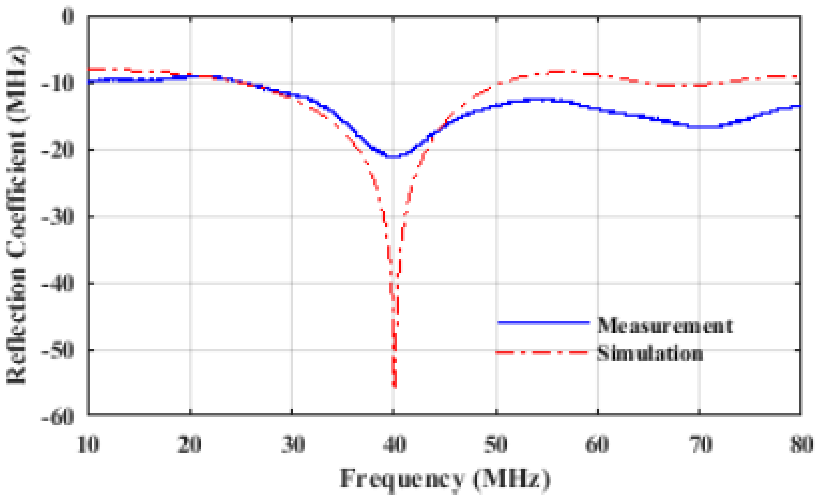

Fig.6 Simulation versus Measurement J-pole Antenna

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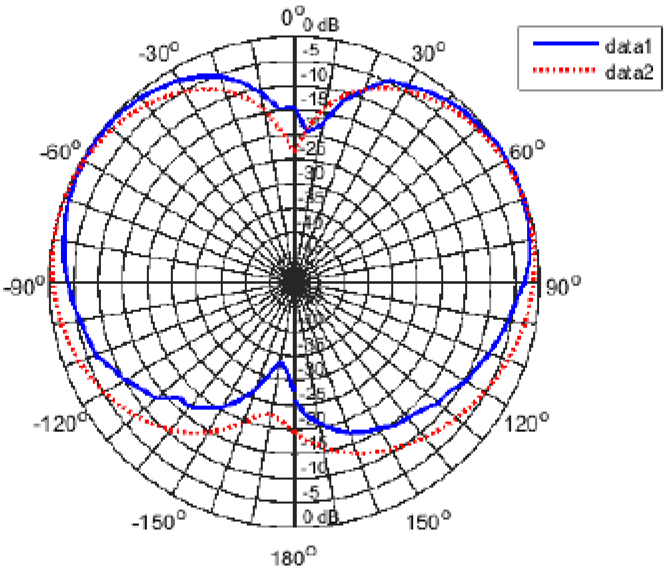

Fig.7 E-plane Radiation Patterns of the J-pole Antenna

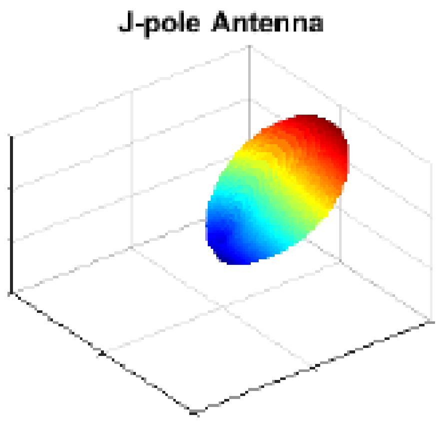

Fig.8 3D Radiation Pattern of J pole antennas in sea water

IV. CONCLUSION

In fresh water, the J-pole antenna features a higher bandwidth and directivity and is, thus, desirable for applications during this medium. The radiation pattern of the dipole antenna is omni-directional while the J-pole antenna is directed towards the short arm. In sea water the J-pole still has a higher directivity, with the maximum directivity only in one direction unlike the other antennas that show bidirectional patterns. The J-pole one would be the natural choice for operation in either fresh or sea water, due to its better performance in terms

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of bandwidth and directivity. Similarly, the beam of the J-pole antenna is wider in sea water, which is another advantage when considering usage of the antennas during this medium.

REFERENCES

[1] J. Lloret, S. Sendra, M. Ardid, and J. J. P. C. Rodrigues, “Underwater wireless sensor communications in the 2.4 GHz ISM frequency band,” Sensors, vol. 12, no. 4, pp. 4237–4264, 2012.
[2] E Geetha, C Nagarajan, “Induction Motor Fault Detection and Classification Using Current Signature Analysis Technique”, 2018 Conference on Emerging Devices and Smart Systems (ICEDSS), 2nd and 3rd March 2018, organized by mahendra Engineering College, Mallasamudram, PP. 48-52,2018
[3] H. Zhang, D. Geng, G. Zhang, and T. A. Gulliver, “The impact of antenna design and frequency on underwater wireless communications,” IEEE Pacific Rim Conference on Communications, Computers and Signal Processing (Pacrim), pp. 868–872, univ Victoria, Victoria, Canada 2011.
[4] T. D. James, Z. Q. Teo, D. E. Gómez, T. J. Davis and A. Roberts. 2013. The plasmonic J-pole antenna. Appl. Phys. Lett. 102, 033106.
[5] C.Nagarajan and M.Madheswaran - ‘Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques’- Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011
[6] Richardson Dan. March 1998. The J-Pole Revisited. CQ Magazine: 34-41.
[7] Nuraiza bt. Ismail, M.T Ali , N.N.S.N. Dzulkefli, R. Abdullah, S. Omar , Design and analysis of microstrip Yagi antenna for Wi-Fi application, 2012 IEEE Asia-Pacific Conference on Applied Electromagnetics (APACE 2012), December 11 - 13, 2012, Melaka, Malaysia
[8] Vinay Bankey, N. Anvesh Kumar, Design of a Yagi-Uda Antenna with gain and bandwidth Enhancement for Wi-Fi and Wi-Max Applications, International Journal of Antennas (JANT) Vol.2, No. 1, January 2016, pp-1-14
[9] Boncho Bonev, Peter Petkov, Nina Spassova, Modified Fractal Super J-pole Antenna, Conference: ICEST 2016, at Ohrid, Macedonia, June 2016
[10] C. Nagarajan, M.Madheswaran and D.Ramasubramanian- ‘Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model’- Acta Electrotechnica et Informatica Journal , Vol.13 (2), pp.18-31,April-June.2013