ISSN 2348 – 9928
IJAICT Volume 4, Issue 11, March 2018 Doi:01.0401/ijaict.2018.03.08 Published on 05 (04) 2018

DESIGN OF MULTIBAND CONFORMAL LOOP ANTENNA FOR TELEMETRY APPLICATIONS

Dr. P. Rajeswari
Assistant Professor

Mr. A. Gobinath
Assistant Professor

Ms. B. Deebiga
UG Scholar

Ms. S. Gnanasundari
UG Scholar

Department of Electronics and Communication Engineering,
Velammal College of Engineering & Technology,
Madurai, Tamilnadu, India

Abstract*— *The conformal antenna consisting two loop elements is presented at 2.45 GHz industrial, scientific and medical band. The two elements are attached on the inner surface of the capsule, so that inner capsule space is saved to its maximum extent. Additionally, by orthogonally placing the two elements at bottom and side of the capsule, different polarization directions are achieved; therefore, resulting in good isolation without introducing additional decoupling structures. This system has the potential to provide real-time biological information from within the human body via a radio frequency link. Furthermore, communication link of the conformal antenna with outside dipole is evaluated, revealing reliable communication performance. The performance of the communication link between the implanted antenna and external half-wavelength dual-band dipole is also examined.

Keywords — Conformal Antenna, Telemetry, Ingestible Capsule

I. INTRODUCTION

Wireless capsule endoscopy provides the great advantage of not involving the introduction of instruments into the body. It involves the diagnoses of diseases in gastro-intestinal (GI) tract and avoids pain or sedation-related problems brought by conventional endoscopes. The small size of the capsules makes them easy to swallow and allows access to the small bowel, which is difficult to reach using conventional endoscopes. In wireless capsule systems the role of antenna is very important. In this ideology of wireless ingestible capsule the conformal antennas has been used which are designed to conform or follow some prescribed shape or structure. The conformal antenna is being adopted to save the inner space of the capsule and to ensure high data rate for real- time high- resolution image transmission, most of the current studies focused on bandwidth enhancement of the antenna. However, such approach was not enough due to the channel bandwidth limitation. Thus, conformal antenna system was proposed to improve the channel capacity and overall link quality without using additional spectrum. This capsule endoscopy makes use of two loop antennas which are placed in a manner orthogonal to each other. a novel capsule conformal antenna is proposed with good isolation at 2.45 GHz industrial, scientific and medical (ISM) band. Besides, due to the polarization diversity of the two loop elements, good isolation is realized without introducing additional decoupling structures. Furthermore, by adjusting the relative port positions of two elements, the isolation performance could be highly improved.[2]

II. PROPOSED ANTENNA DESIGN

The overall view of the proposed Conformal antenna, whose size is 10mmX12mm (diameter ×height), consisting of two loop elements. The capsule is formed by wrapping substrate of taconic tlx-6 ($_r$ = 2.55, tan δ = 0.0019) with a thickness of 0.254 mm. To save the inner space of the capsule for necessary electronics, the two loop antennas are attached on the inner wall of the capsule in conformal form, with one horizontally located, labelled as loop_1 and the other one vertically located, labelled asloop_2, with a separation distance of 1 mm. During simulation, the capsule is placed in the centre of muscle tissue, 30 mm away from each side of the tissue box.[1],[2] Biocompatibility.

For real implantation cases, the whole implanted device should be covered by biocompatible materials. This encapsulation layer not only protects the antenna from the conducting effect of human tissue, but also reduces the coupling of the antenna's high near field terms of the electromagnetic radiation with the surrounding human tissue. Also the effect of the biocompatible encapsulation layer on the impedance matching and gain of the antenna is significant therefore we should take it into consideration when designing implantable antennas.
[5]

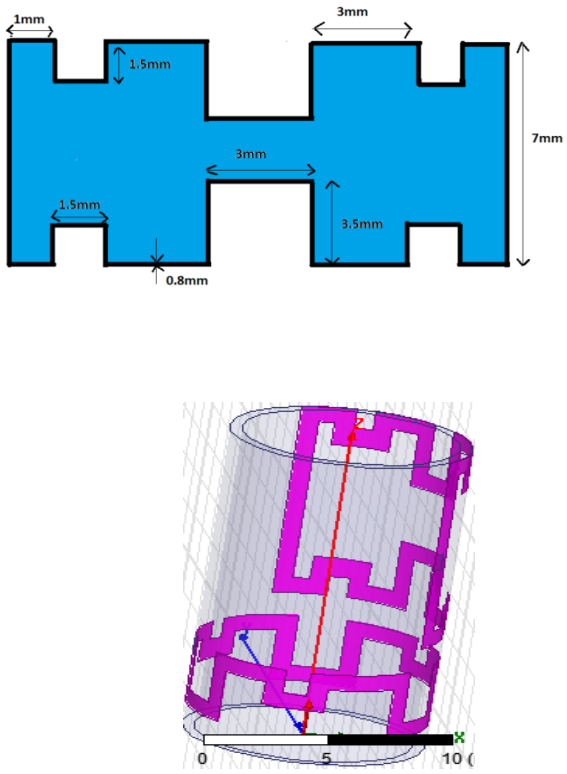


Fig 1:Proposed Antenna and Simulated Structure

By taking full consideration of the specific capsule structure, the two loop elements are orthogonally located without taking inner space of the capsule. Besides, such placement of two elements can bring in polarization diversity, resulting in good isolation without additional decoupling structure. Under this circumstance, the isolation performance could be further improved by adjusting the relative position of two feeding ports, which are represented by . In this case, can be tuned by rotating loop_1 around capsule centre, in which case = 0° means the two ports are vertically aligned. The simulated |S21| of the proposed conformal loop antenna with different rotation angles is compared. The antenna achieves good isolation for all circumstances due to its inherent polarization diversity.[1]

Various simulation environments have been proposed in the past research papers, three-layer tissue including skin, fat and tissue, skin mimicking tissue , and muscle equivalent tissue . The shape of the body phantom is either a cubic box or a cylinder. Also, from past experience, the shape and size of the body tissue only present a negligible influence on the impedance matching of the implanted antenna, as long as the dielectric properties of the tissue remains the same. Additionally, the differential reflection coefficients in three-layer tissue are similar to those in one-layer tissues.[3]

The antenna possesses the qualities necessary to act as an effective capsule antenna:

- Conformal geometry that exploits the surface of the capsule leaving the interior open for electrical components;
- Miniaturization to achieve matching at the desired 1.4-GHz biotelemetric frequency;
- Omnidirectional pattern very congruent to that of a dipole;
- Polarization diversity that enables the capsule to transmit more efficiently regardless of its orientation;
- Easy and straightforward tuning adjustment to compensate for body effects.[2]

III RESULTS AND DISSCUSION

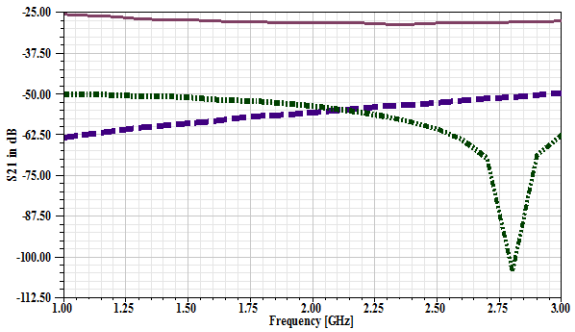


Fig 2 : Simulated |S21| of Existing capsule MIMO antenna with varying of relative port position

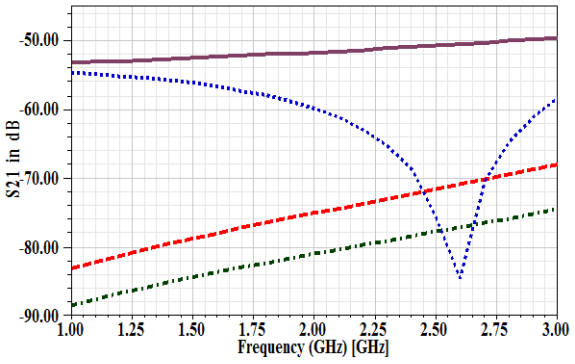


Fig 3 : Simulated |S21| of proposed capsule MIMO antenna with varying of relative port position

In the frequency range of 2.45GHz the return loss of the antenna is measured to be -55db but in the proposed structure the gain is measured to be-50db

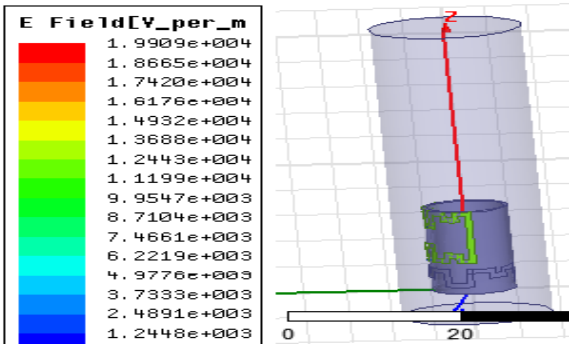


Fig 4: E Field of proposed capsule MIMO antenna

With ports 1 and corresponding to loop_1 and loop_2,a maximum coupling of −24.4 dB can be achieved for minimum coupling of −55 dB can be achieved , indicating reliable communication in all cases.

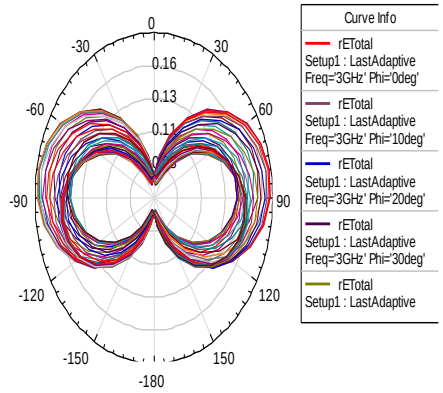
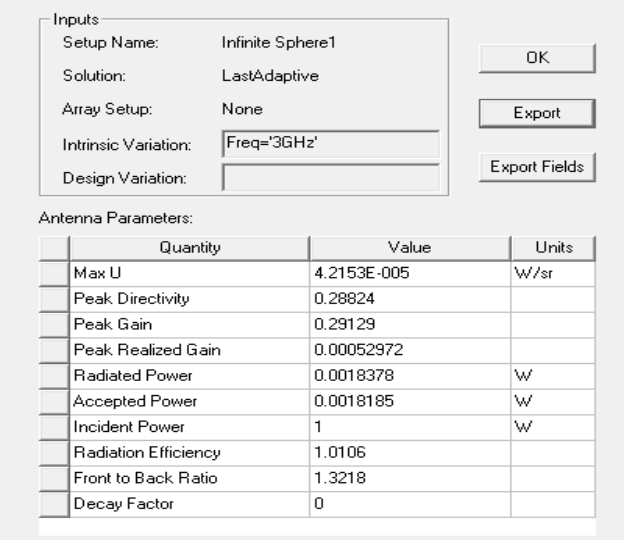


Fig 5 : Radiation Pattern of proposed capsule MIMO antenna



	Quantity	Value	Units
	Max U	4.2153E-005	W/sr
	Peak Directivity	0.28824	
	Peak Gain	0.29129	
	Peak Realized Gain	0.00052972	
	Radiated Power	0.0018378	W
	Accepted Power	0.0018185	W
	Incident Power	1	W
	Radiation Efficiency	1.0106	
	Front to Back Ratio	1.3218	
	Decay Factor	0	

Fig 6 : Simulated antenna Parameters of proposed capsule MIMO antenna

IV. CONCLUSION

In this paper, conformal loop antenna technology is introduced in ingestible capsule system to improve its channel capacity and gain. Two loop elements are adopted and orthogonally attached on the inner surface of capsule in conformal form, sparing space for system electronics. Besides, due to polarization diversity of the two loop elements, good isolation performance is realised with simple structure. The proposed antenna reveals its good candidacy for real-time data transmission in future wireless capsule endoscopy system.

References

[1]. Li- Jie Xu, Bo Li, Ming Zhang and Yaming Bo'Conformal MIMO loop antenna for ingestible capsule applications' The Institution of Engineering and Technology 2017 Submitted: 12 July 2017 E-first: 5 October 2017 doi: 10.1049/el.2017.2683

[2]. Izdebski, P.M., Rajagopalan, H., and Rahmat-Samii, Y.: 'Conformal ingestible capsule antenna: a novel chandelier meandered design', Trans. Antennas Propag., 2009, 57, (4), pp. 900–909, doi 10.1109/TAP. 2009.2014598

[3]. Haldorai, A. Ramu, and S. Murugan, "Social Aware Cognitive Radio Networks," Social Network Analytics for Contemporary Business Organizations, pp. 188–202. doi:10.4018/978-1-5225-5097-6.ch010

[4]. Haldorai and A. Ramu, "The Impact of Big Data Analytics and Challenges to Cyber Security," Advances in Information Security, Privacy, and Ethics, pp. 300–314. doi:10.4018/978-1-5225-4100-4.ch016

[5]. Y. Sumin, K. Kihyun, and N. Sangwook, "Outer-wall loop antenna for ultra wideband capsule endoscope system," IEEE Antennas Wireless Propag. Lett., vol. 9, pp. 1135–1138, 2010.

[6]. C. Liu, Y. X. Guo, and S. Xiao, "Circularly polarized helical antenna for ISM-band ingestible capsule endoscope systems," IEEE Trans. Antennas Propag., vol. 62, no. 12, pp. 6027–6039, Dec. 2014.

[7]. Emerging biomedical applications (Invited)," in Proc. IEEE Int. Symp. RadioFreq. Integr. Technol., 2015, pp. 139–5. M. Je et al., "Wireless sensor micro systems for 141.

[8]. Duan, Z., Guo, Y., Je, M., et al.: 'Design and in vitro test of a differentially fed dual-band implantable antenna operating at MICS and ISM bands', Trans. Antennas Propag., 2014, 62, (5), pp. 2430–2439, doi: 10.1109/TAP.2014.2309130

[9]. H. Anandakumar and K. Umamaheswari, "A bio-inspired swarm intelligence technique for social aware cognitive radio handovers," Computers & Electrical Engineering, Sep. 2017. doi:10.1016/j.compeleceng.2017.09.016

[10]. Poshtgol, P.L., Li, J., Soltani, S., et al.: 'MIMO antennas for capsule endoscope systems'. IEEE Int. Symp. Antennas and Propagation (APSURSI), Fajardo, Puerto Rico, June 26 – July 1, 2016, pp. 1175–1176, doi: 10.1109/APS.2016.7696295

[11]. Duan, Z., Guo, Y., Xue, R., et al.: 'Differentially fed dual-band implantable differentially fed dual-band implantable', Trans. Antennas Propag., 2012, 60, (12), pp. 5587–8895, doi: 10.1109/TAP.

[12]. R. Das and H. Yoo, "A wideband circularly polarized conformal endoscopic antenna system for high-speed data transfer," IEEE Trans. Antennas Propag., vol. 65, no. 6, pp. 2816–2826, Jun. 2017.

[13]. F. Merli, L. Bolomey, J. Zurcher, G. Corradini, E. Meurville, and A. K. Skriverviky, "Design, realization and measurements of a miniature antenna for implantable wireless communication systems," IEEE Trans. Antennas Propag., vol. 59, no. 10, pp. 3544–3555, Oct. 2011

[14]. H. Anandakumar and K. Umamaheswari, "An Efficient Optimized Handover in Cognitive Radio Networks using Cooperative Spectrum Sensing," Intelligent Automation & Soft Computing, pp. 1–8, Sep. 2017. doi:10.1080/10798587.2017.1364931

[15]. W. A. Qureshi, "Current and future applications of the capsule camera," *Nature Rev. Drug Disc.*, vol. 3, pp. 447–450, May 2004.

[16]. K. Gosalia, M. S. Humayun, and G. Lazzi, "Impedance matching and implementation of planar space-filling dipoles as intraocular implanted antennas in a retinal prosthesis," *IEEE Trans. Antennas Propag.*, vol. 53, no. 8, pp. 2365–2373, Aug. 2005.

[17]. A. Nesic, S. Jovanovic, and I. Radnovic, "Wideband printed antenna with circular polarization," in *Proc. IEEE Antennas Propag. Symp.*,