Design Of Miniaturized Implantable Antenna For Bio-Medical Devices

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Abstract- The leadless cardiac pacemaker introduces a compact implantable antenna system. A circularly polarized pentagon-shaped antenna is proposed for Leadless Pacemaker application. Operating in WMTS 1.4GHz and ISM 2.45GHz bands, it enables wireless medical telemetry services. Utilizing UWB for heart disease detection offers low-cost, fast-response diagnostic devices. With dimensions of 44x30mm², the antenna, fabricated on FR4-substrate, exhibits promising performance on human tissue and body phantom, as validated through simulations and measurements.

Keywords – Simulation,Pentagon shape antenna,FR4-substrate & HFSS Software

I. INTRODUCTION

Pacemakers, vital for Bradycardia patients, combat slow heart rate diseases like Syncope and hypertrophic cardiomyopathy, preventing cardiac arrest. Over 5 million Americans and 25 million globally suffer from cardiac issues, with over 3 million pacemakers installed worldwide. Since the successful 1958 implantation, pacemakers have evolved significantly, with advancements in size, programming, battery life, and monitoring. Despite reducing mortality rates, conventional pacemakers pose infection risks due to subcutaneous pockets and transvenous leads. Fifty years ago, the idea of leadless pacemakers emerged, with initial trials in the 1970s and 1990s showing promise but facing technical challenges. By 2013, technological improvements enabled successful implementation of self-contained leadless pacemakers, driven by advancements in catheter-based systems, low-power devices, and compact energy sources.

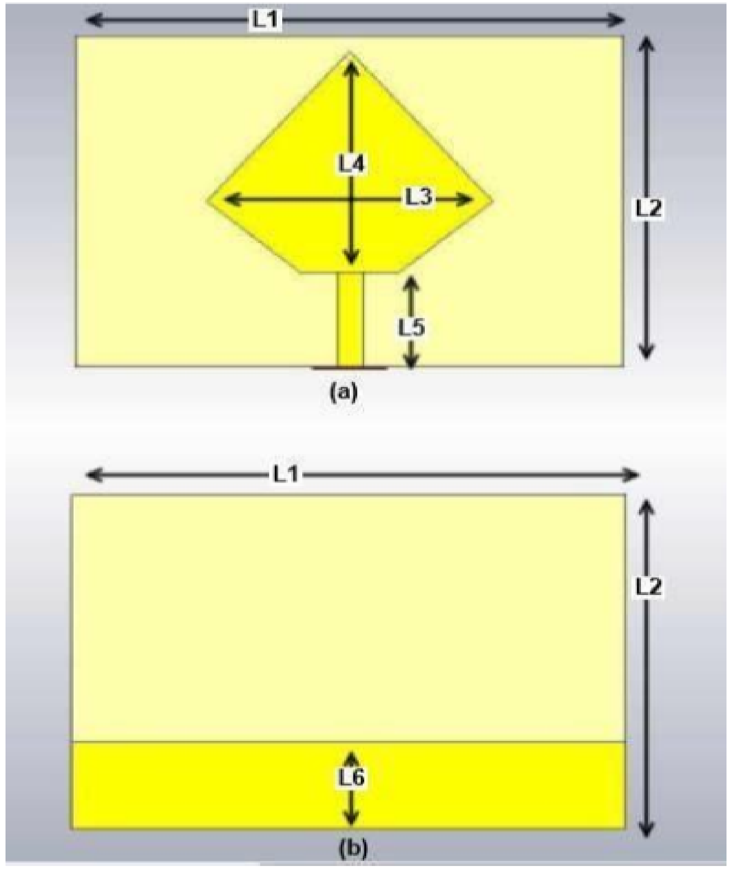
II. Proposed Algorithm

An UWB pentagon antenna is implemented on FR4-substrate with relative permittivity 4.4, and thickness 1.5 mm. It has dimensions 44x 30mm2 . The antenna is feeded through a 50 ohm matched microstrip line. It has an omnidirectional radiation pattern. The antenna can be obtained with different strategies, edges and curves. It has a truncated ground such that other modes can be on setting and it can contribute with other frequencies.

UWB ANTENNA

UWB stands for ultra wideband or ultraband frequencies.UWB, or ultra wideband, utilizes frequencies from 3.1 GHz to 10.7 GHz in the US, ideal for high-speed data, medical imaging, and short-range radars. Unlike spread spectrum, UWB doesn't conform to conventional narrowband and carrier wave transmission, making it suitable for short-distance applications like PC peripherals. With low emission levels, indoor UWB systems are commonly used for short-range purposes. UWB pulses, with their short length, enable easy construction of high data rates, where data rate can be exchanged for range. Additionally, high-data-rate UWB facilitates efficient file transfer between mobile phones, portable media players, cameras, and monitors, enhancing wireless connectivity across devices.

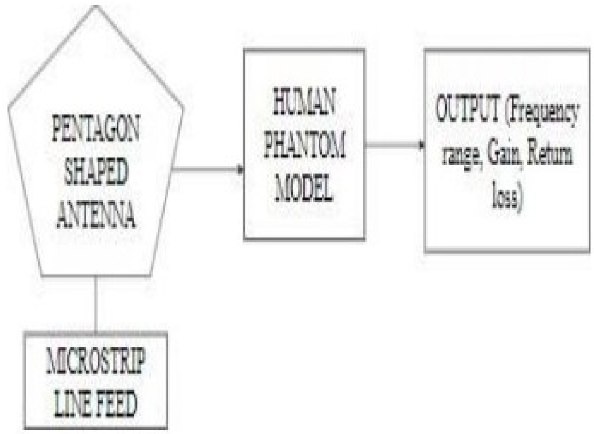
Here a pentagon shaped antenna is proposed to detect cardiac signal and tumour, The figure below displays the design. Figure: Geometry of an antenna (a) Front image (b) Rear view



There has been very little research done on deeply implantable antennas for leadless pacemakers.This is because designing implantable antennas is difficult because of space constraints, multipath losses brought on by human tissues that are lossy, and adjacent electronics modules. The leadless pacemaker's capsule length and diameter in this study are in accordance with Medtronic's MICRA TCP system13.

In designing the suggested implantable antenna, we also made an effort to replicate the internal and external environments of the TCP system. We have employed 26 mm in length and 6.7 mm in diameter ceramic alumina capsules, which are biocompatible materials.

BLOCK DIAGRAM



III. EXPERIMENT AND RESULT

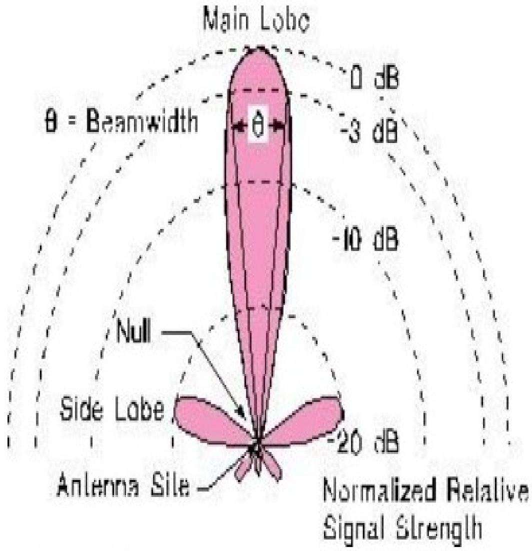
ANTENNA PARAMETER

DESIGN BANDWIDTH: The bandwidth is defined within a specific Voltage Standing Wave Ratio (VSWR) as the frequency range.Given that the bandwidth is a function of the tolerable mismatch, it can vary depending upon the application.

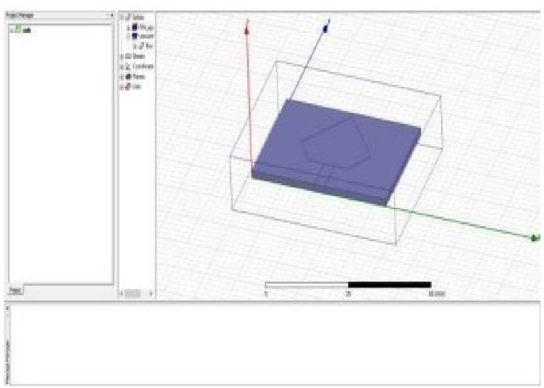
EFFICIENCY: The antenna's overall efficiency is influenced by the feed matching network, height, width, loss tangent, and patch resistivity.To get the most radiation efficiency out of your antenna you want the lowest loss tangent and the lowest receptivity that is available in materials.

ANTENNA GAIN: Antenna gain is the ratio of the radiation intensity in a given direction to the emission intensity that would arise from the antenna's willingness to accept in isotropic fashion radiated power. The radiation intensity that corresponds to the isotropically radiated power is calculated by dividing the power that the antenna accepts input by 4.

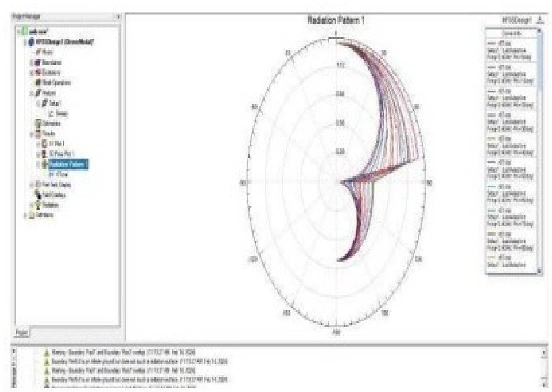
FIELD REGIONS: Lobes are different areas of a radiation pattern that can be further divided into major or main, minor, side, and back lobes. A section of the radiation pattern surrounded by areas of comparatively low radiation intensity is known as a radiation lobe.



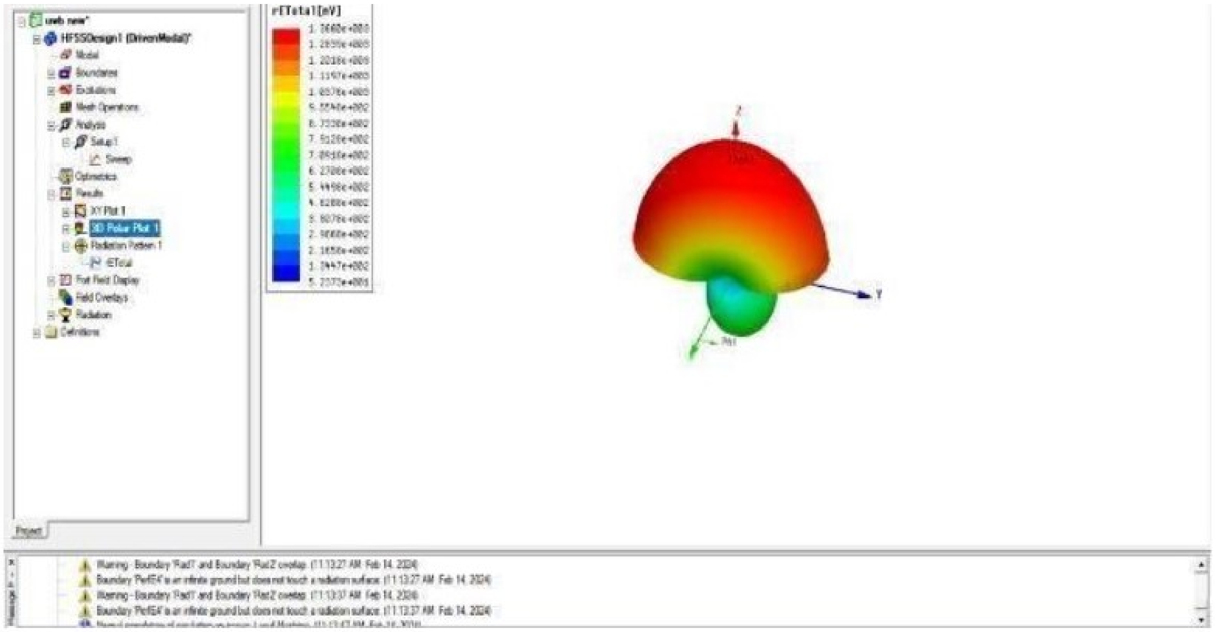
OUTPUT



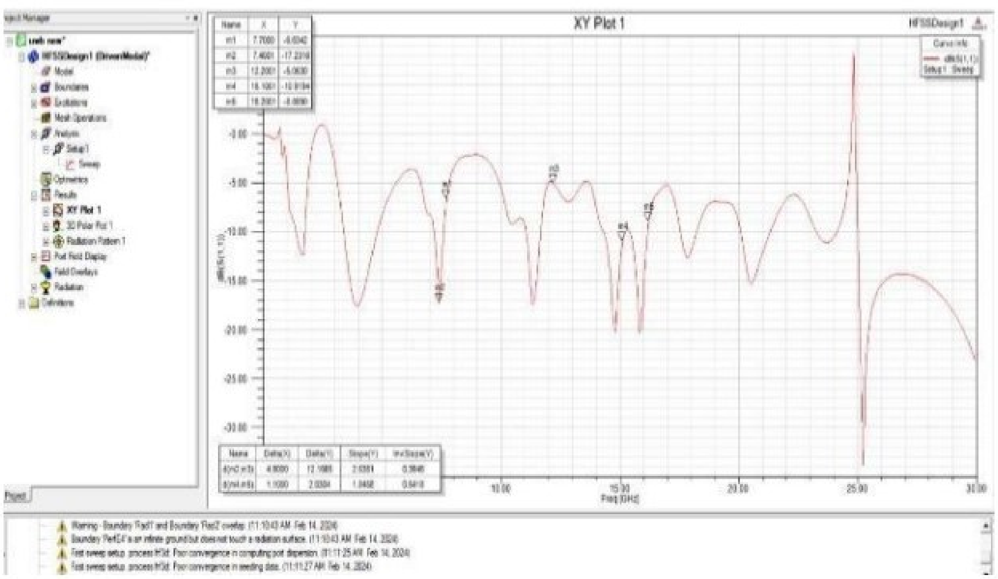
Patch Antenna – Pentagon shape



Radiation Pattern



3D POLAR PLOT



OUTPUT SIMULATION

IV. CONCLUSION

The paper delineates the plan and usage of a pentagon receiving wire for mind growth and heart disease location, situated straightforwardly on human's body. It is reproduced utilizing HFSS microwave studio and created on 1.5 mm thick FR-4 substrate with a relative permittivity of 4.4. It is called attention to that there is a recurrence move of frequency shift between the ordinary body show and the one recreated with tumour and heart disease when reenacted on body model. The pentagon receiving wire is additionally measured on a normal body apparition. The various parameters are measured for the proposed structure and the design is fabricated on FR-4 substrate.

REFERENCES

[1] J. Gray and B. Fitzgerald, "Flash disk opportunity for server applications," ACM Queue, Vol.6(4), July/August 2008.
[2] "Pure storage," https://www.purestorage.com/.
[3] J. Colgrove, J. D. Davis, J. Hayes, E. L. Miller, C. Sandvig, R. Sears, A. Tamches, N. Vachharajani, and F. Wang, "Purity: Using commodity components to build enterprise flash storage that is quick and highly available." in Proceedings of the 2015 ACM SIGMOD International Conference on Management of Data (SIGMOD '15).
[4] "Netapp solidfire," https://www.solidfire.com/.
[5] "Dell emc xtremio," https://www.dellemc.com/enus/storage/xtremio- all-flash.htm.
[6] M. Hao, G. Soundararajan, D. Kenchammana-Hosekote, A. A. Chien, and In the Proceedings of the 14th USENIX Conference on File and Storage Technologies (FAST '16), H. S. Gunawi presents "The tail at the works: A revelation from millions of hours of disk and SSD deployments."
[7] J. He, D. Nguyen, A. C. ArpaciDusseau, and R. H. Arpaci-Dusseau, "Reducing file system tail latencies with chopper." in Proceedings of the 13th USENIX Conference on File and Storage Technologies (FAST '15).
[8] "Flash on rails: Consistent flash performance through redundancy," By D. Skourtis, D. Achlioptas, N. Watkins, C. Maltzahn, and S. A. Brandt, Proceedings of the 2014 conference on USENIX International technical conference (ATC '14).
[9] S. Yang, T. Harter, N. Agrawal, S. S. Kowsalya, A. Krishnamurthy, S. Al- Kiswany, R. T. Kaushik, A. C. ArpaciDusseau, and R. H. Arpaci-Dusseau, "Split-level i/o scheduling," in Proceedings of the 25th Symposium on Operating Systems Principles (SOSP '15).
[10] M. Jung, W. Choi, S. Srikantaiah, J. Yoo, and M. T. Kandemir, "Hios: a host interface i/o scheduler for solid state disks," in Proceeding of the 41st annual international symposium on Computer architecuture (ISCA'14).