Microstrip Patch Antenna Simulation for Cranial Implant

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***Abstract*—** The Ultimate objective of this paper is to simulate an antenna for medical applications. The Antenna is made to Resonate at a particular frequency or specific application. Microstrip patch antenna Brings true awareness to the powerful devices they connect and simplify the lives. Its modest size and simple construction make it highly appealing. Microstrip Patch Antenna is made to resonate at 5.8 GHz for a cranial implant. CST Microwave Studio, a commercially available simulation program, was used to create the simulation of the Microstrip Patch Antenna. Slots are created at the patch such that it resonates at a particular frequency. Various return loss value is obtained at several frequencies. The return loss and gain obtained from the antenna is up to -34.4dB and 3.60214 respectively

***Keywords*—** Rectangular Microstrip Patch Antenna, Cranial Implant, Return Loss, VSWR, Bandwidth, Gain, Directivity

I. INTRODUCTION

Microstrip Patch antennas are increasing popularity and becoming highly appealing in current and future wireless communication systems. It is especially intended to transmit and/or receive electromagnetic radiation for very brief periods of time. It is well understood that Microstrip Patch Antenna design continues to be a crucial element in to measure distance with high degree of accuracy [4]. In order to provide improved efficiency and gain, Microstrip Patch Antenna is used [9]. The power density ranges from 1/10,000 to 1/100,000. So the impact on human health is negligible. Microstrip patch antenna provides better medical applications without the demand for manual labor or physicians to track sportsmen and health issue patient's body conditions. Most connected devices rely on what and when to anticipate our needs. . Microstrip patch antenna provides a third eye that can see in every direction [3] [5]. The implanted antenna uses uplink and downlink to communicate with the outside source. The implant antenna is connected to the external device via an uplink, and the external device is in communication with the implant antenna via a downlink. A metal patch with a dielectric material in between it is called a micro strip or patch antenna. Microstrip or patch antennas are gaining popularity as a result of the fact that they may be printed directly onto a circuit board [11]. Due to their low profile design, which is often square or rectangular, they can be installed on flat surfaces [1]. The prospective antenna must operate at the frequency of 5.8 GHz. If the resonating frequency and dielectric constant of the material used in substrate is known, it is easy to calculate the width and length of the patch antenna using the below formulae (1) (2)

$$width = \frac{c}{2f_0\sqrt{\frac{\varepsilon_R+1}{2}}} \tag{1}$$

$$\varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12(\frac{h}{w})}}\right]$$

$$Length = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{eff}-0.258)(\frac{w}{h}+0.8)}\right) \tag{2}$$

Formula to Calculate Width and Length

To confirm the utility of the current proposed design, results in terms of VSWR, Return Loss, and Bandwidth Efficiency will be shown

II. DESIGN FLOW

The design flow for the entire project is:

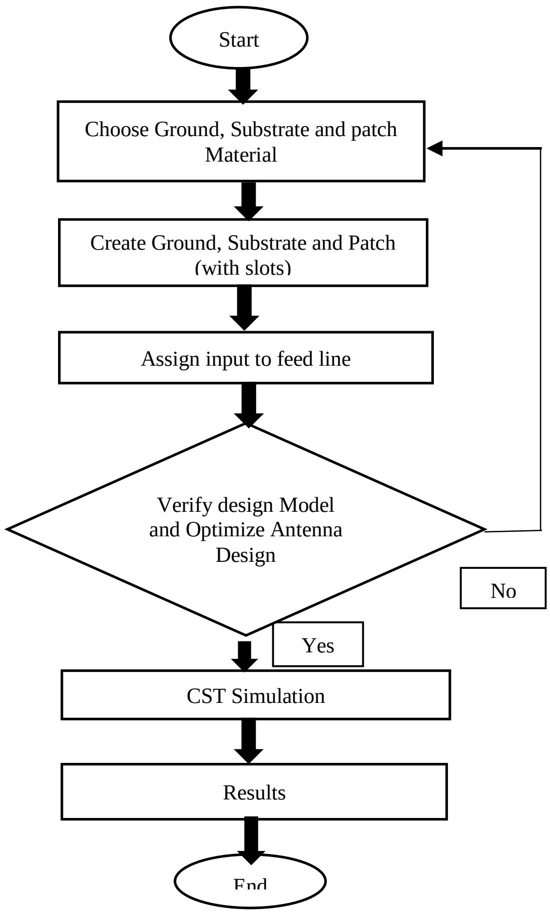

Fig. 1. Design flowchart

III. MICROSTRIP PATCH ANTENNA FOR CRANIAL IMPLANT

Microstrip patch antenna is very popular due to its light weight conformability and low cost. Over the last two decades, wireless communication has increased at an exponential rate. It can communicate across great distances. A ground plane and a radiating patch are attached to a dielectric substrate on opposite sides to form a microstrip patch antenna [6]. The patch is often made of conductive metals like copper or gold and can be produced in any shape. Usually, the feed lines and radiating patch are photo etched onto the dielectric substrate [12]. The fringing fields that lie between the patch boundary and the ground plane those are what cause Microstrip patch antennas to emit [8] [9]. The designed antenna is made from FR-4, a low-cost and widely accessible dielectric material with a permeability of 4.4

IV. ANTENNA DESIGN

The antenna designed for cranial implant is rectangular in shape with the slots at the patch [1] [2]. Ground is created with the dimension of 44 x 41 and substrate is created with the same dimension above the ground. Out of the three layers, ground and patch uses copper as a material thickness of 0.035mm [13] [14]. The substrate is made of FR-4, which has a dielectric constant of 4.3 and a thickness of 1.6mm. A slot is created at the center with the same thickness (0.035) and that is subtracted from the patch such that its performance is been enhanced. By creating the slots and patch, the antenna structure is optimized to resonate at particular frequency [2] [7]

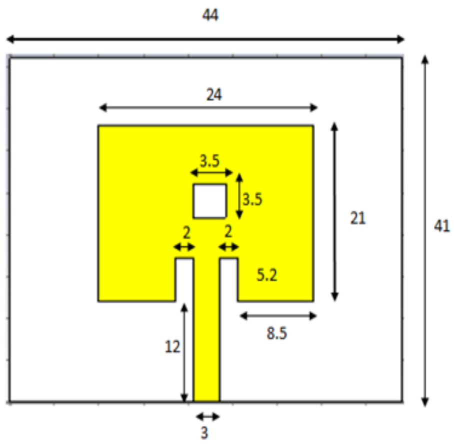

Fig. 2. Proposed antenna structure with dimensions

The thermal expansion capabilities of copper and the circuit board base material FR4 are advantages. Because of its inexpensive cost and mechanical qualities, FR4 is still the preferred substrate for many applications. The usage of FR-4 material as a substrate has a high strength to weight ratio, light weight and moisture resistant

V. DESIGN REQUIREMENTS

The designed antenna's dimensions are critical in achieving the desired outcomes [8]. The design considerations for a rectangular micro strip patch antenna are listed in the table below

TABLE. 1. Antenna design parameters with dimensions

Notation	***Value(mm)***	***Description***
Wp	24	Width of the patch
Wg	44	Width of the ground
Wf	3	Width of the feed
Wc	2	Width of the cut
Lp	21	Length of the patch
Lg	41	Length of the ground
Lf	12	Length of the Feed
Lc	5.2	Length of the cut
ht	0.035	Thickness of ground and patch
hs	1.6	Thickness of Substrate

VI. FINAL DESIGN

The finalized antenna structure obtained using this design process is depicted in below figure using the CST software

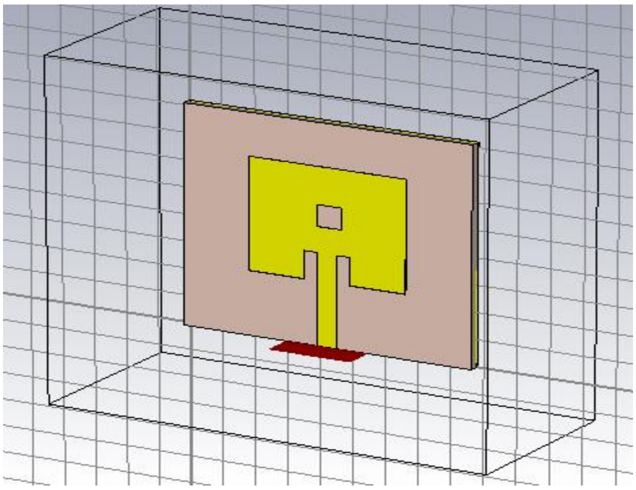

Fig. 3. Front View of Antenna structure

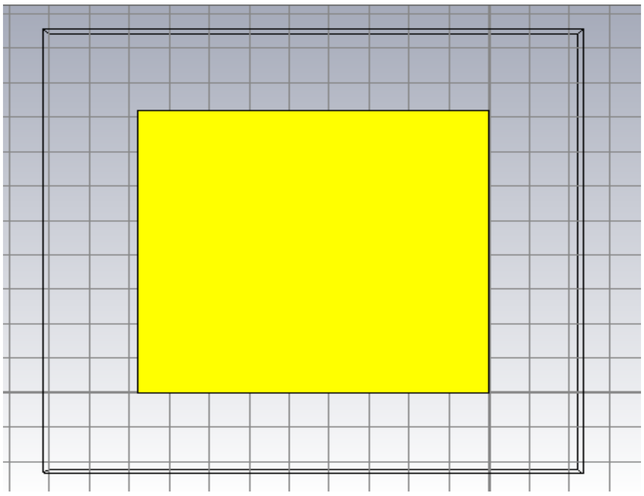

Fig. 4. Back View of Antenna Structure

VII. SIMULATED OUTPUT

The antenna is analyzed with the parameters like Return loss, VSWR, Bandwidth and Gain along with radiation pattern. The bandwidth obtained in this design is 290MHz

1. RETURN LOSS

Return loss measures the intensity of a "return" or reflection/echo or the power of a reflected wave or signal travelling back to a transmitter from an antenna. The average return loss must be less than-10dB. The obtained return loss is-34dB

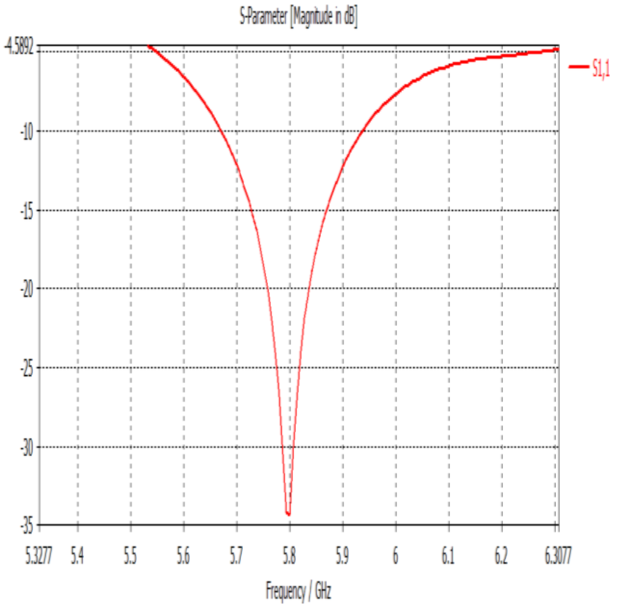

Fig. 5. Return loss

2. VSWR

Voltage Standing Wave Ratio is the name given to it. The parameter for this dimensionless ratio (which has no units of measurement) is the same as return loss; it is just stated on a different scale. VSWR is a rather antique measurement that was frequently made by the transmitter when it was transmitting into an antenna. The ideal VSWR value must be less than 2. The obtained VSWR value is 1.041215

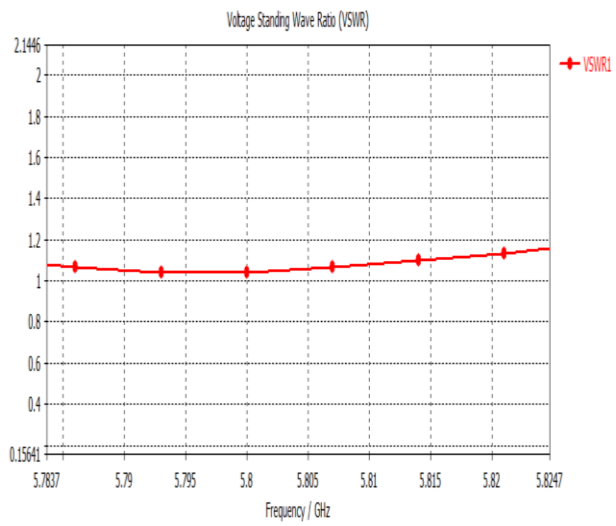

Fig. 6. VSWR

3. RADIATION PATTERN

When defining the radiation pattern as a mathematical function or graphic depiction of the properties of the antenna's far field radiation, the electromagnetic (EM) wave's direction of departure is taken into consideration.

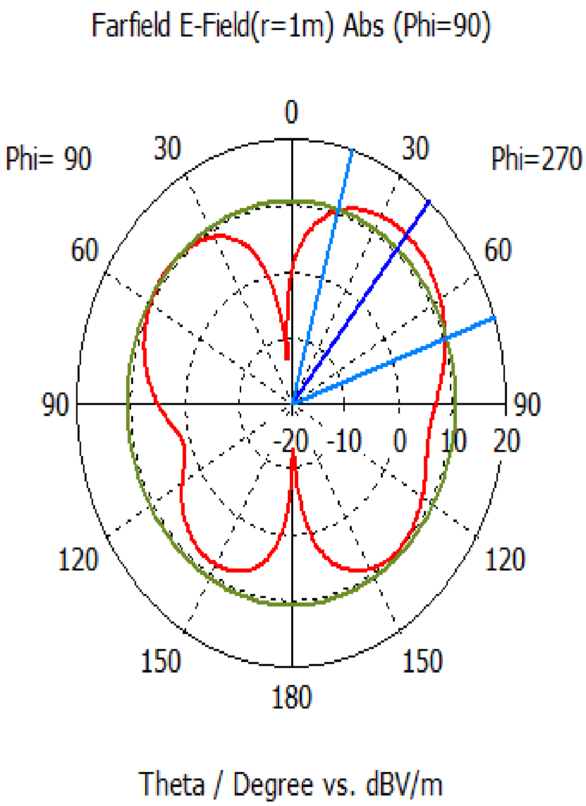

Fig. 7. Radiation pattern for E-Field

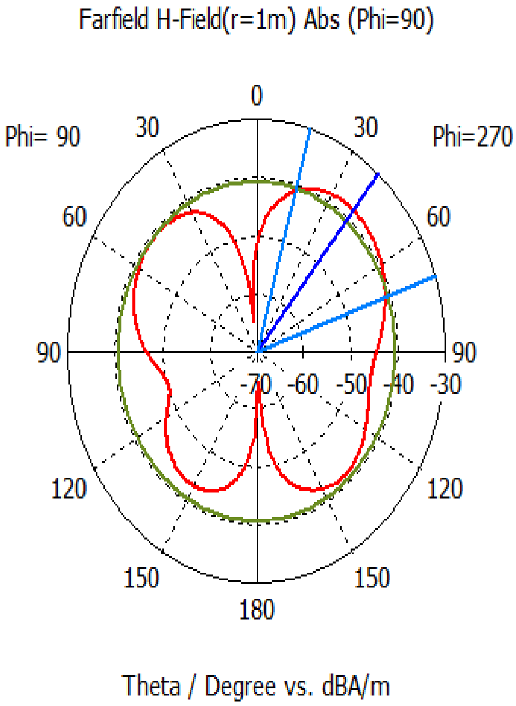

Fig. 8. Radiation pattern for H-Field

4. GAIN

Gain of 3.602 db was attained for the Microstrip patch antenna design for cranial implant

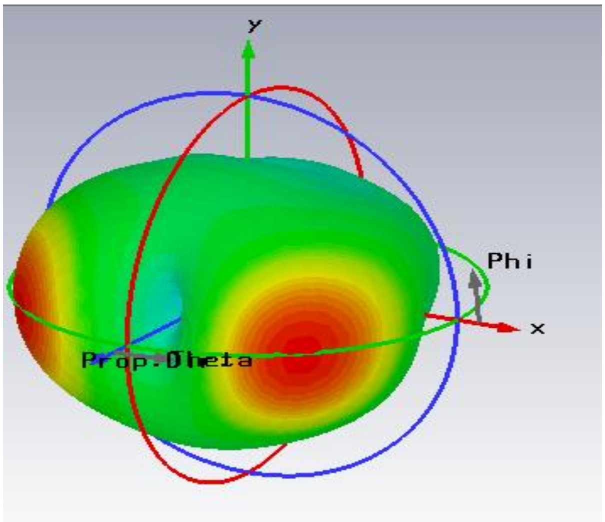

Fig. 9. Gain

5. DIRECTIVITY

The directivity obtained is 5.279dB for the cranial implant using Microstrip patch antenna

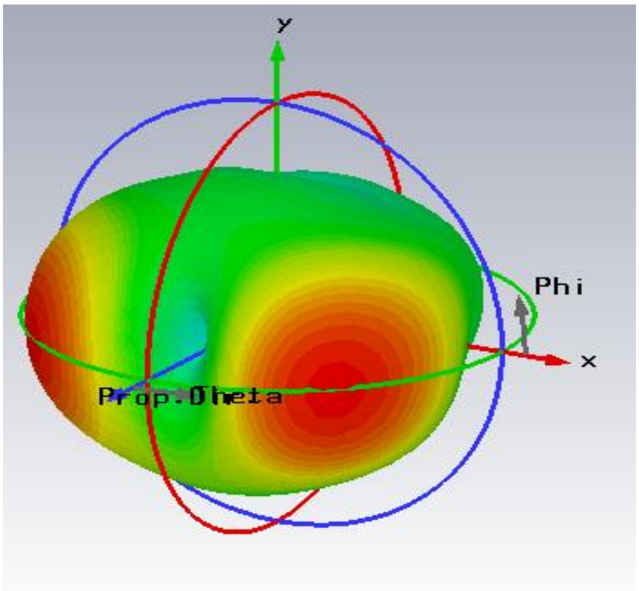

Fig. 10. Directivity

VIII. CONCLUSION

Cranioplasty is a surgical procedure that repairs a bone defect or deformity in the skull with the help of cranial implants [13]. The majority of such anomalies are repaired to restore the structure and function of the lost cranial bone. The designed Antenna produces better VSWR value, return loss and efficient Bandwidth. With microwave integrated circuits, it is simple to integrate. Thus it is best suitable for the cranial implant in medical application [10]

IX. REFERENCES

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