Microstrip patch antenna design for brain cancer detection

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■ **Abstract:**

Brain cancer is an abnormal proliferation of brain cells, which can be classified as benign or malignant. In this study, a micro strip antenna was developed that operates at microwave frequencies in the ISM band. It was implemented on a simplified model of both normal and abnormal brain tissue, and it was used to compare the return loss, gain, and directivity, as well as the electric field, magnetic field, and specific absorption rate, in order to detect the presence of a stage II tumor. CST microwave studio was used for all simulations and results.

• **Keywords:** Micro strip Patch Antenna, Brain Cancer, and ISM Band.

■ **المستخلص:**

في هذه الدراسة، تم تطوير هوائي شريطي صغير يعمل على ترددات الميكروويف في نطاق الترددي الطب تم تنفيذه على نموذج لرأس مبسط لكل من أنسجة المخ الطبيعية وغير الطبيعية ، وتم استخدامه لمقارنة خسارة العودة ، والكسب ، والاتجاهية ، وكذلك المجال الكهربائي ، والمجال المغناطيسي ، ومعدل الامتصاص النوعي، نظرا لاختلاف الخصائص العازلة للأنسجة السليمة وغير الطبيعية عند ترددات الميكروويف يمكن استخدام هذا الاختلاف لتحديد ما إذا كان النسيج الورمي موجودًا أم لا. تم استخدام برنامج محكاة للتصميم الهوائي والنموذج الراس وإخرج النتائج ومقارنتها.

• **الكلمات الافتتاحية:** هوائي الشريطي ، وسرطان الدماغ ، ونطاق ISM.

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1. Introduction

After leukemia, brain cancer is the second most common type of cancer in children, according to the World Health Organization (WHO). There is a difference between benign and malignant forms of this aberrant brain cell development. The many grades used to classify brain tumors include: The tumor is significantly smaller than normal cells in stage 0 and grows and spreads much more slowly than cells in stages I, II, and III. Stage 0 tumors are amenable to surgery because their cells have not yet spread to nearby tissues. Phase I: Compared to Arrange II and Organize III tumor cells, organize I tumor cells develop more gradually. They may spread to adjacent tissue and conclusion up being expelled. This.

This arrange of tumors may gotten to be the next stage of tumor in the event that it isn't identified prior. Organize II: The tumor cells see diverse from the lower organize cells and develop more rapidly than organize and I tumor cells. They are likely to spread into adjacent tissues. Organize III: The measure of the tumor gets to be anomalous than the ordinary cells, it would create speedi er. Organize III tumors ordinarily cannot be cured. (1)

Sophisticated imaging strategies can pinpoint brain tumors. Symptomat ic instruments incorporate computed tomography (CT or CAT filter) and at tractive reverberation imaging (MRI).Other MRI groupings can offer assis tance the specialist arrange the resection of the tumor based on the area of the ordinary nerve pathways of the brain. Intraoperative MRI moreover i s utilized amid surgery to direct tissue biopsies and tumor expulsion. Attr active reverberation spectroscopy (MRS) is utilized to look at the tumor›s chemical profile and decide the nature of the injuries seen on the MRI. Positron outflow tomography (PET filter) can offer assistance identify repeat ing brain tumors. (2)

A brain MRI employments a solid attractive field to produce pictures of the brain, and Ultrasonic Imaging employments high-frequency sound waves to create other pictures for the brain. Both of them are as a rule prescribed as the follow-up strategies when the Brain radiography produces a positive result, to conclude an perfect location strategy ought to fulfil the taking after three criteria: Secure and comfortable precise with tall accuracy, and reasonable. (4).Since MI employments microwaves so it's employing a miniaturized scale strip radio wire which it's comfortable, has moo fabricating taken a toll, more precise than the ultrasonic and the IRT, and more secure to utilize at that point the Brain radiography innovation. The working guideline of the

MI method hand-off on the esteem of dielectric steady between solid and an omalous tumor tissues. In this way, dielectric and conductivity of tissue are used for obsessive acknowledgment to distinguish surrendered and solid tiss ue. (3)

In this paper, rectangular small scale strip fix receiving wire was planned on the ISM-band and utilized to identify brain cancer. Depending on the reference (4), a disentangled show for the typical and the contaminated brain tissue was outlined upon the receiving wire structure so that return misfortune, pick up, and directivity are measured and compered to identify or find the nearness of the tumor. All recreations are executed utilizing CST mw studio. Area 2 outline the brain demonstrate and the radio wire plan points of interest, Segment 3 and 4 outline the recreation & comes about and conclusion, individually.

2. Brain module and antenna design

The simplified normal brain model is consisting of six layers which is skin, fat, Bone, Dura, CSF and Brain tissue as shown in Figure 1, each with their electrical properties as sown in Table I.

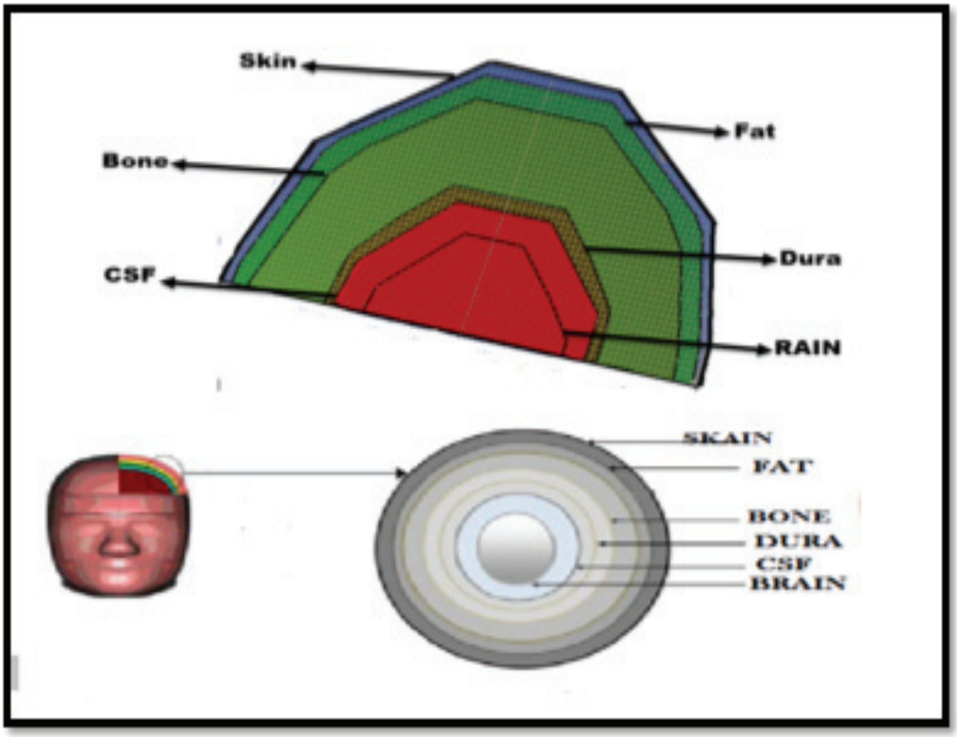

Figure 1: Normal brain tissue

Table 1: Electrical Properties of Brain Tissue [9]

Tissue	Dielectric constant	Conductivity $(\frac{S}{m})$	Massdensity $(\frac{g}{m^3})$
Skin	38.1	1.44	1100
Fat	5.29	0.102	1100
Bone	11.41	0.385	1850
Dura	42.1	1.64	1030
CSF	66.3	3.41	1030
Brain	42.6	1.48	1030

The antenna is installed on the brain so that the patch touches the skin layer as in Figure 2 and the reason for this is that the radiation goes out towards the patch, so the value of S11 will be greater than any value. The infected breast tissue contains a cylinder l tumor in the canter with dimeter of 2.5mm to represent the stage I of Breast cancer as shown in figure 3. The dielectric constant of the tumor is 50 and the conductivity is 4 S/m [14].

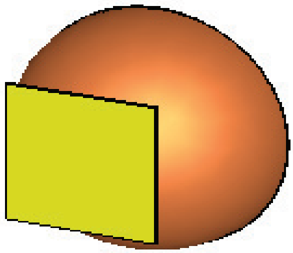

Figure 2: Install the antenna on the brain

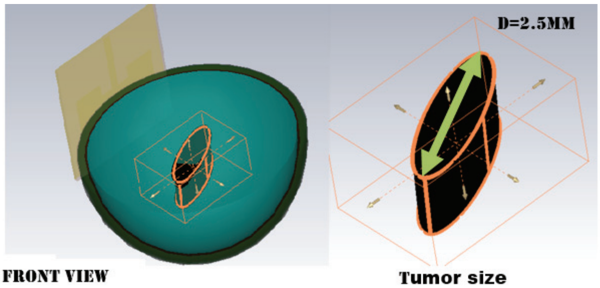

Figure 3: Infected brain tissue

The designed antenna working on ISM-band at 2.4 GHz and Copper was used to designing the conductive parts of this antenna, FR-4 with of 1.6 mm height and 4.3 dielectric constants is used as the substrate between the patch and the ground plane. The antenna was optimized using CST microwave studio software and the overall antenna size was 2.9∗5cm with two slots in the patch and adding two equal holes 5 mm wide and 5.4 mm long, as shown in figure 3. The physical parameters of the proposed antenna are given in table II.

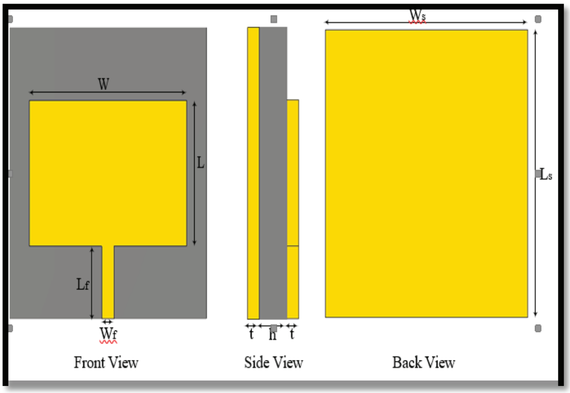

FIGURE 2 :(A) THE PRIMARY DESIGN OF THE ANTENNA.

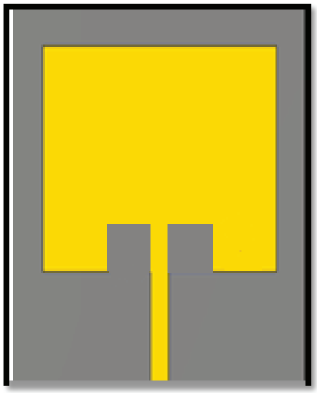

FIGURE 3: (B) ANTENNA ADDING INSET FEED GAP

Table II: Physical parameters of the proposed antenna

Parameter	Value(mm)
h	1.6
t	0.035
W	29.77
L	38.39
W_s	50
L_s	50
W_f	3.11
L_f	17.29

3. Simulation and result

2.1 Brain phantom with tumors

A small sphere which has a largedielectricconstantof50andconductivityof4 S/m, the highest size of the tumor is 2.5 cm in diameter. Is consider as a tumor on the brain with different numbers and simulated separately for each cases to ensure the performance of the proposed antenna. The simulation results for 3 cell shows in figure 4.

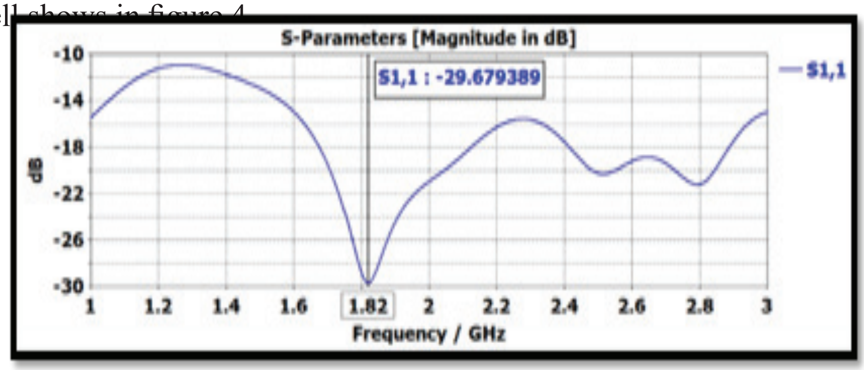

Figure 4(a): Return loss at 1.82 GHz - with 3 cell tumors.

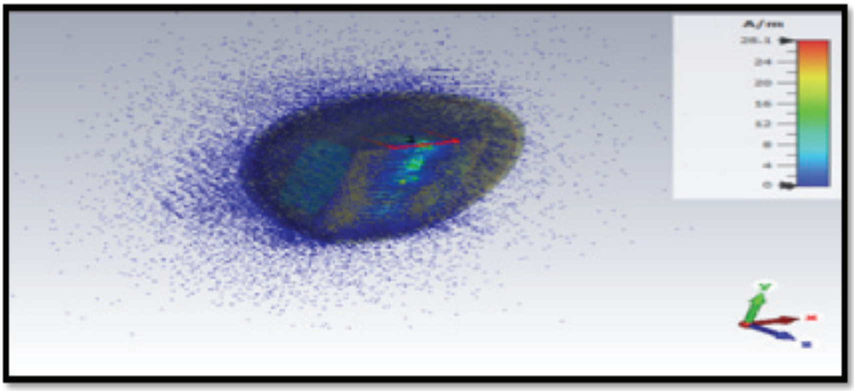

Figure 5 (b): H-field at 2.4GHz - with 3 cell tumors.

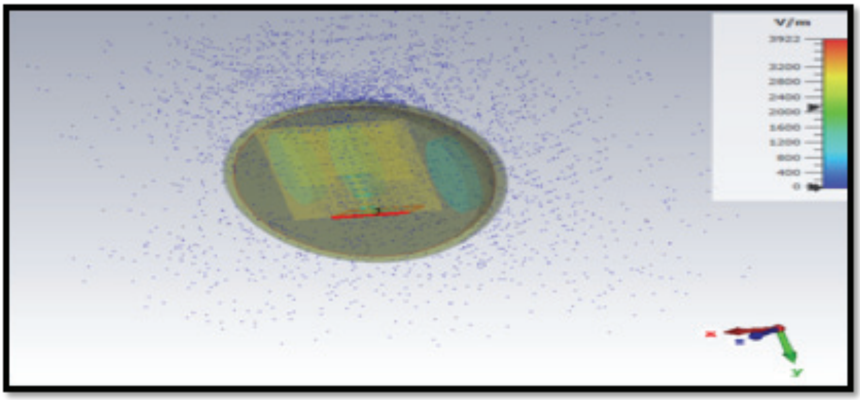

Figure 4: (c): H-field at 2.4GHz - with 3 cell tumors.

2.2 - **Effect of tumor tissues**

Figure 5, illustrate the return loss for the antenna when implemented in each of normal and infected brain tissues. The minimum S11 for the normal brain tissue was -37.3dB, and the minimum S11 for the infected breast tissue was --20dB.The addition of a tumor causes by adding different number of tumors lead to change in the return loss, gain and directivity due to the large difference between the dielectric constant of the normal and the infected tissue, this difference can be used to determine whether or not the tumorous tissue exists.

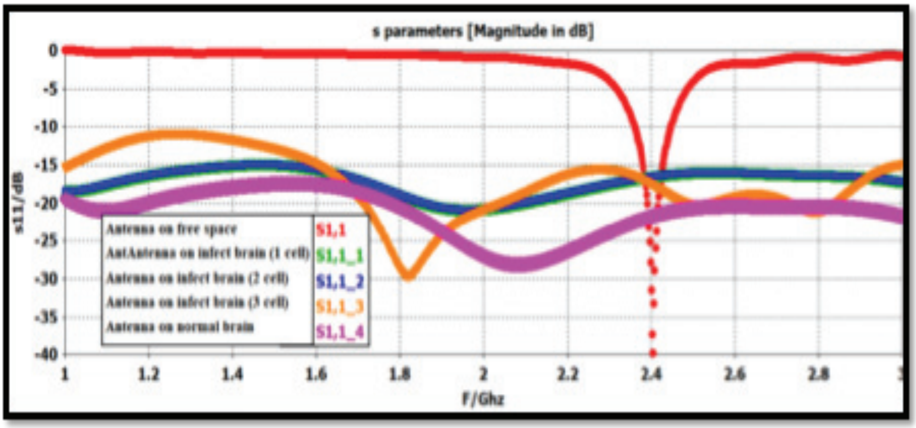

Figure 5: Effect of tumorous tissue

Table III: S11, Gain, Directivity-Filed and E-Filed for 5 cases

Case	S_{11}(dB)	Gain(dB)	Directivity (dB)	H-Filed (A/m)	E-Filed (v/m)
Free space	-37.4	1.99	6.07	10.3	4993
Normal brain	-29	-28.11	4.20	18.6	2158
1 cell of tumors	-20.94	-24	4.03	26.6	2113
2 cell of tumors	-20.93	-23.9	4.01	23.9	2138
3 cell of tumors	-29.7	-29.67	4.98	28.1	3922

2.3 - **Specific absorption rate (SAR)**

The SAR value was calculated by adding the mass density of each layer from Table 4, and the SAR value was as shown in the table on 5. 10 g of tissue and 1 mW of reference power below the European peak limit

Table IV: SAR for 4cases

CASE	SAR(W/KG)	Reference Value
Normal brain	1.420	SAR< 2
1 cell of tumors	0.592	SAR< 2
2 cell of tumors	0.530	SAR< 2
3 cell of tumors	0.383	SAR< 2

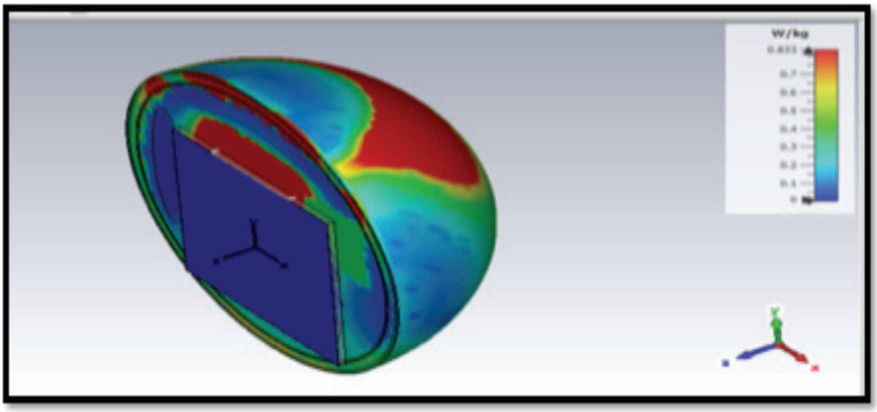

Figure 6: SAR value for 3 cell tumors.

4. Conclusion

In this study, a micro strip antenna operating at ISM-band was used to simulate stage II cancerous tissue on a simplified model of both normal and abnormal brain tissue in order to detect brain cancer. Based on changes in the magnetic field, electric field, return loss, and SAR of the antenna after simulation on a brain phantom with and without tumor, the proposed antenna's performance is assessed. The antenna's return loss on the brain phantom with tumor is discovered to be -20.61GHz, which is lower than the return loss on the brain without tumor. The specific absorption rate for 10 grams of tissue was 0.0505 W/kg, which is less than the rate for a brain without a tumor. There was a distinction the return loss, gain, and directivity that can be used in detecting tumor, also 3 cases were studied. Different cases according to the change in the number of the tumor in the tissue, which can be used to determine the stage of the cancer.

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