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EARLY DETECTION OF BRAIN CANCER USING RECONFIGURABLE ANTENNA ARRAY: A REVIEW

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Abstract: Cancer is considered as one of the most serious and dangerous diseases. It is characterized as the growth of abnormal cells in human body. There are over 100 types of cancer, according to the National Cancer Institute. Brain cancer is one of the most dangerous types of cancers. This paper is to review different antenna design technique, tumour properties, simulation platform, and also an antenna design technique for the early detection of brain cancer was proposed. It includes the design of an antenna and a model for the human head. The antenna used was a reconfigurable four element linear array of squared micro strip patches. The antenna operates at Industrial Scientific and medical (ISM) frequency 2.4GHz. It was designed on FR-4 (lossy) substrate of thickness of 1.6 mm. The simulation calculates the reflection coefficient (S_{11}) with and without tumor.

Index Terms **- Antenna arrays, brain cancer tumors, FR-4 substrate, HFSS simulation, reflection coefficient.**

I. INTRODUCTION

Brain is the most important organ and responsible for all the functions of human body. Brain cancer is one of the most dangerous types of cancers. That is because brain is the most important, critical and complex organ of the human body. It is responsible for the control of the nerves leading to all other organs. Brain tumors are classified into two types. That is primary or secondary. A primary brain tumor originates in the brain itself. A secondary brain tumor, occurs when cancer cells spread to brain from another organ, such as lung or breast. A brain tumor is a mass of cells that have grown and multiplied uncontrollable. Tumors are primarily categorized into two types: Benign and Malignant. Benign tumors are those tumors which are non-cancerous, and malignant ones are those which contain cancerous cells.

The detection techniques like X-ray mammography, magnetic resonance imaging (MRI), and ultrasound are used to detect cancer cells in healthy and non-cancerous tissue. Microwave imaging figure out an alternative detection technique. This technique is based on the fact that microwaves are reflected in different tissues due to differences in their dielectric properties. Microwaves reflect in different tissue due to different dielectrics of the same tissue in different conditions (healthy tissue and malignant tissue)[1].

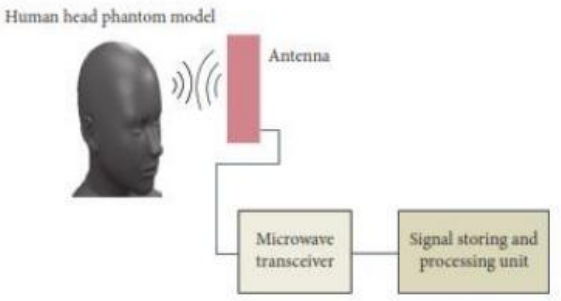

Fig -1: Structure of microwave imaging system

II. LITERATURE SURVEY

1) The design of an UWB Vivaldi Antenna structur for tumor detection of brain cancer is analysed in this paper. The investigation with radiation is carried out inside a human head phantom with a tumor model. FR-4 substrate is used for the design. In this paper, An UWB Vivaldi Antenna is optimized for operation in microwave imaging for tumor detection. Here in this paper various structures are developed. Simulation provides effective tool to optimize the design of the antenna and hence it maximize the energy interaction with the tissues to be detected[1].

2) This paper includes the design and implementation of a pentagon antenna for brain cancer and stroke detection. The antenna is positioned directly on human's head. It is designed to be operating at a band from 3.3568- 12.604 GHz in free space and from 3.818 to 9.16 GHz on the normal head model. Simulated is carried out in CST microwave studio and the antenna is fabricated on FR-4 substrate with relative permittivity 4.4 and thickness 1.5mm. Frequency shift of 213 MHz between the normal head model and the one simulated with tumour is found out here. A frequency shift of 218MHz is also found when the antenna is simulated on head model with stroke. The paper mentioned that pentagon antenna is also measured on a normal head phantom[2].

3) In this paper a pentagon shaped microstrip patch antenna is designed. It is for detecting brain cancer. After the design phase the antenna is affixed in a human head phantom for testing the ability of the antenna to detect the tumor. -30.99dB return loss is measured without cancerous tumor which is at 2.45 GHz resonant frequency. Also in network analyzer there is no significant difference between measured value and simulated result for return loss. Far-field radiation pattern and specific absorption rate (SAR) calculation showed the directivity & safety measurement of the antenna. This paper concludes that the antenna performance is significant for detecting cancerous (malignant) tumor by analyzing return loss and electric field intensity for closer position of tumor towards antenna[3].

4) In this paper, a compact metamaterial based microstrip patch antenna is designed. The antenna is designed using CST simulation software for efficient brain tumor detection. The variations in SAR, magnetic field and current density of the antenna is evaluated based on the simulation carried upon brain phantom model with & without tumor. The current density value of 629 A/m2 is found using the antenna when simulated upon brain phantom with tumor. This value is twice than that of the brain without tumor. Also the specific absorption rate of 68055 W/m3 which is much greater than that of the brain having no tumor[4].

5) High gain ultra-wide band (UWB) reflector array antenna for human brain tumor detection using specific absorption rate (SAR) technique in microwave detection system is proposed in this paper. Based on SAR technique the antenna is successfully detecting human brain tumor. The presence of tumor inside the human brain can be identified when the amount of energy or gain produced by the antenna which being absorbed by the human brain. More energy is absorbed by human brain with tumor and recorded higher SAR value compared to human brain without tumor. In this paper, SAR value of 2.53 W/kg and 2.51 W/kg for simulated and measured respectively is recorded for human head phantom associated with tumor. And human head phantom without tumor have the SAR value of 1.06 W/kg for simulated and 1.05 W/kg for measured[5].

6) Rectangular microstrip patch antenna was successfully designed and analysed using the computer simulation tools. The antenna is operating in the frequency range of 2- 2.483GHz. The variations in magnetic field, electric field, return loss and SAR value of the antenna is measured to evaluate the performance of the proposed antenna which is simulated upon the brain phantom with and without tumor. A return loss of -34.61GHz which is higher than that of the brain without tumor is found when the antenna is simulated upon the brain phantom with tumor. Also the specific absorption rate of 0.0505W/kg for 1gm tissue which is higher than that of the brain without tumor[6].

7) In the multilayer brain phantom model a Rectangular microstrip patch antenna is designed for cancer tumor detection. Computer simulation technology-Microwave Studio (CST-MWS) is used for designing. Also simulated a multilayer brain phantom model with five layers and proposed. Spherical-shaped tumor of radius 05 mm has been designed inside the multilayer brain phantom model. The microwave signal is transmitted into the brain through RMPA (Rectangular Microstrip patch Antenna).Then the reflected signal from the brain phantom model with and without tumor has been analyzed. The detection of tumor is based on their performance parameter. The increased value of current density and SAR and the declined value of the return loss with the proposed model detects the cancerous tumor[7].

8) This paper analyses the dielectric permittivity and conductivity of various canine tumor and normal tissues. Works at frequencies from 10 MHz to 18 MHz. The mechanism that are responsible for the dielectric properties of the tissues are emphasized here in this paper. The variation in the dielectric properties with tissue water content are discussed and provide simple empirical formulas to allow the estimation of the dielectric properties of other soft tissues on the basis of the net tissue water content[8].

9) The main choice for several PCB application is FR4 epoxy glass substrate material. It is very low cost and also has excellent mechanical properties. Because of these reason making it ideal for a wide range of electronic component applications. To characterize the dielectric materials for the use at microwave frequencies there were number of relatively simple test methods included in this paper. Using these methods, the characteristics of FR4 substrate has been assessed between 1 and 15 GHz.Two microstrip lines, one short and one long, from which both the losses and dielectric constant can readily be found over a wide range of frequencies are used as the most widely applicable technique[9].

10) The design of microstrip rectangular patch antenna is included in this paper. The antenna operates at a center frequency of 2.5GHz for WiMAX application. The array of four by one (4x1) patch array microstrip rectangular antenna with microstrip line feeding based on quarter wave impedance matching technique was designed. It is simulated using Computer Simulation Tool (CST) Microwave Environment software. Return loss, Voltage Standing Wave Ratio (VSWR), bandwidth, directivity, radiation

pattern and gain of designed antenna is compared with the single patch rectangular antenna. For the fabrication of array antenna FR-4 substrate is used. The material is having dielectric constant value of 4.9 and thickness of 1.6mm[10].

11) For brain cancer detection a smart antenna array is designed in this paper. Three ultra-wideband vivaldi antennas is included in the smart antenna array. A brain model with 4 layers is created. It is simulated using the CST Microwave Studio.It scatters more energy when the antenna array focuses on tumor. Also less for when the antenna array focus point moves away from the tumor[11].

12) HFSS was the first general-purpose software product introduced during 1990 to solve arbitrary three-dimensional electromagnetic field problems. The software includes a number of new technologies in computational electromagnetics including automatic adaptive mesh generation, tangential vector finite elements, transfinite elements, and reduced-order modeling. This paper describes the early development of HFSS and also the issues critical to its success. There were some recent advances that enable HFSS to solve more complex problems quickly and accurately[12].

13) For the maximum power transfer in every part of RF systems like transceiver, amplifier and antenna designing an impedance matching network is a central issue for optimum performance. To calculate the input impedance of patch antenna there were various design formulae and techniques to design a matching network should be known to RF designer. Various impedance matching techniques along with their design equations are presented in this paper. Different antenna structures like rectangular, circular and triangular patch antenna are used to calculate the input impedance[1]

14) In this paper, antennas with circular polarization has been designed. Design is carried out with the help of IE3D electromagnetic simulator. For this simulation four different geometry has been choosen. In that, 2 similar slots have been etched diagonally on the square microstrip patch. To create and prove circular polarization behavior four slots like square, circular, ring and cross-shaped was selected. The required circular polarization characteristics is obtained through Axial ratio (A.R.) performance plot. Reflection coefficient, impedance plot and three dimensional patterns are used to characterize the antenna performance. In order to validate the procedure one of the antennas was fabricated in the laboratory and experimentally measured [14].

15) Some of the most important characteristics of antennas are Frequency,bandwidth, gain and dimensions. A comparison of the most important characteristics of circularly polarized microstrip antennas (CP MSAs), using traditional methods, is accomplished in this article[15].

III. METHODOLOGY

The early detection of brain cancer technique is proposed. FR4-substrate is used to design the squared patch antenna. It having relative permittivity (εr) = 4.3 and thickness 1.6 mm with loss tangent (δ) = 0.025. The array have the dimension of 200mm × 78mm. The substrate is above a rectangular metallic ground plane with thickness 0.035mm. The square patch have a side length of 30 mm. Simulation will carry out using HFSS simulation tool. The changes of reflection coefficient (S11) is calculated to distinguish between head phantom with and without tumor[16].

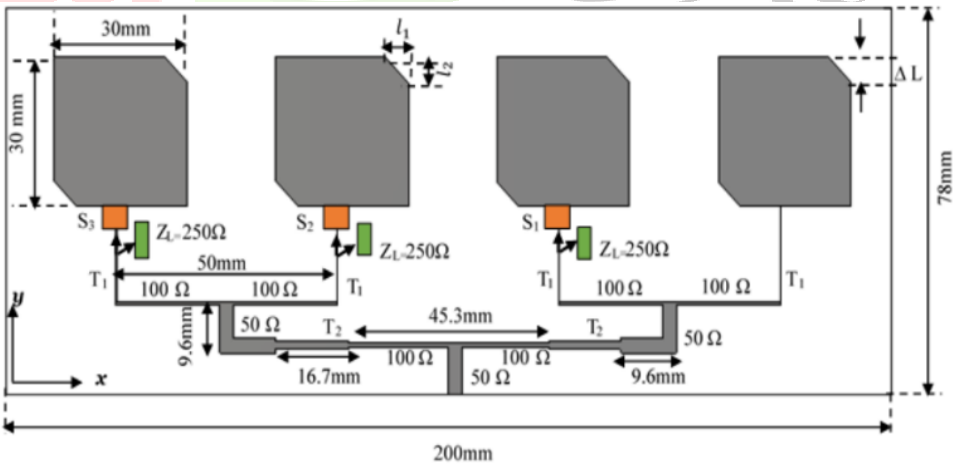

Fig -2: geometrical structure of proposed antenna-top view of the antenna array structure with switches.

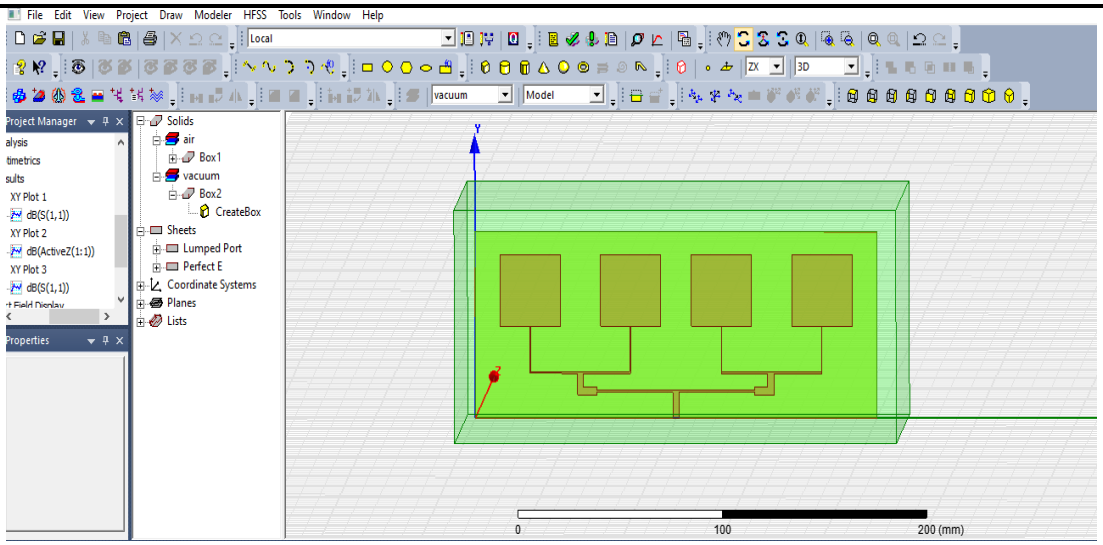

Fig -3: HFSS software simulation

IV. CONCLUSION

Reviewed different antenna design technique, tumour properties, simulation platform for the early detection of brain cancer. A reconfigurable four-element antenna array will be designed for brain tumor detection. HFSS software is used for the simulation of proposed method.

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