Microwave Wearable Antenna for Brain Tumour Sensing Analysis

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Abstract- *Non-invasive tumour detection especially in the Head and Neck region is always a matter of keen interest to mankind. Wearable antenna are used for 'body wearing electronic devices' such as watches, and these devices should be low radiating so that the radiological effects on human systems are either minimised or eliminated as below the threshold value. Here a body wearable microwave antenna is made to analyse the radiation over the body, using this sensing of the radiation, the presence and the location of any tumour can be established, due to the differential electrical activity of a tumour. The design of a microwave antenna system for such a system design is challenging and also fascinating. Brain tumor is one of the most important diseases and hence its detection should be fast and more accurate. This can be achieved by using execution of automated tumor detection techniques on medical images. Presently using medical imaging techniques are Magnetic Resonance Imaging (MRI), Computerized tomography (CT) and Microwave, which cannot detect below 3mm size and it can be detected using Infrared imaging techniques. In this paper we, using Near Infrared Imaging Technology to detect the brain tumor of the size below 3mm which could not be detected using CT and MRI images. MRI depends on magnetic activity in the brain and does not use X-rays, so it is considered safer than imaging techniques that do use X-rays. It is a non-invasive method for detecting tumors. Brain tumors have different characteristics such as size, shape, location and image intensities and it may deform neighboring structures and if there is edema with the tumor, intensity properties of the nearby region change. In adults, the most common and cancer-causing tumor type is glial tumors that have a high mortality rate. Over 90% of all tumours in persons over 20 years are glial tumours.*

Keywords- Non-invasive brain tumor; antenna; micro imaging; wearable antenna; EEG waves.

I. INTRODUCTION

In this rapid changing world in wireless communication systems, multiband antenna plays an important role for wireless service requirements. The current trend in commercial and government communication systems have been to develop low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies. Through the years, slotted micro-strip patch antenna structure are the most common option used to realize millimeter wave monolithic integrated circuits for microwave, radar and communication purposes. Within this operating range of frequency, the antenna should have stable response in terms of gain, radiation pattern, polarization etc. At the same time it should be of small size, conformal, low cost and should be easily integrated into the RF circuits.

Slotted micro-strip patch antenna can also be printed directly onto circuit board. Since the slotted micro-strip patch antenna requires few materials, it is low cost, easy to manufacture and light weight. These characteristics make slotted micro-strip patch antennas ideal for use in cell phones and other small electronic devices. Slotted micro-strip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight, low profile planar configuration and capability to integrate with micro wave integrated circuits technology, the slotted micro-strip patch antenna is very well suited for applications such as wireless communication systems, cellular phones, pagers, radar systems and satellite communication systems.

The size of the slotted micro-strip patch antenna is inversely proportional to its frequency. For this reason, slotted micro-strip patch antennas are generally used for ultra-high frequency signals. Slotted micro-strip patch antenna is capable of sensing frequencies lower than microwave would be too large to use.

With the rapid development of modern communication and semiconductor technologies, a wide variety of wireless service has been successfully introduced worldwide in the past few years. Antenna plays a vital role in any wireless communication. A well designed antenna relaxes the complexity and improves the performance of the receiver. The dimension, type and the configuration of the antenna depends on the application and the operating frequency.

II. LITERATURE REVIEW

A. Microwave System For Head Imaging[1]

A wideband microwave system for head imaging is presented. The system includes an array of 16 corrugated tapered slot antennas that are installed on an adjustable platform. A switching device is used to enable the antennas to sequentially send a wideband 1–4 GHz microwave signal and capture the backscattered signals. Those signals are recorded using suitably designed virtual instrument software architecture. To test the capability of the system to detect brain injuries, a low-cost mixture of materials that emulate the frequency-dispersive electrical properties of the major brain tissues across the frequency band 1–4 GHz are used to construct a realistic-shape head phantom. A target that emulates a realistic haemorrhage stroke is fabricated and inserted in two different locations inside the fabricated head phantom. A pre-processing algorithm that utilizes the symmetry of the two halves of human head is used to extract the target response from the background reflections. A post-processing con focal algorithm is used to get an image of the phantom and to accurately detect the presence and location of the stroke.

B. Dual-Polarized, Broadside, Thin Dielectric Resonator Antenna For Microwave Imaging[2]

We present a design for a dielectric resonator antenna (DRA) with dual-polarization characteristics. This antenna is de- signed for use in a three-dimensional (3-D) microwave to thermography system to collect co-polar and cross-polar responses. The broadside radiation and dual polarization are achieved by exciting the fundamental mode of the DRA as well as by using two elements of the DRA that are perpendicular to each other. Compared to the conventional rectangular DRA, the proposed antenna is reduced in size by a factor of 6.7. The proposed DRA offers a measured bandwidth of 72% (2.6–5.52 GHz). The performance and radiation characteristics of the antenna are verified experimentally.

C. A Compact Double-Layer On-Body Matched Bowtie Antenna For Medical Diagnosis[3]

A compact double-layer Bowtie antenna optimized for medical diagnosis is presented in this paper. This on-body antenna is matched to the human body to allow more energy to be radiated into the human body to obtain stronger reflections for image processing. By using a Bowtie antenna with double layers as well as a folded structure and meandered micro strip lines at the bottom of the antenna, a small size of 30 30 mm with a size reduction of 40% is achieved, compared to the reference antenna of 50 50 mm within the same operational frequency range. After the optimization of the antenna parameters, the antenna is characterized from 0.5 to2 GHz, where the low frequencies enable a high penetration into human body and the large frequency range contributes to a high bandwidth and hence a fine range resolution. The simulated and measured results are shown with respect to the impedance matching, near-field pattern, gain and SAR distributions. With features such as a very small size, very low operational frequency, high front-to-back ratio, this design shows a high potential for use in medical diagnosis of stroke, breast cancer and water accumulation detection in the human body.

D. Bandwidth Enhancement Of A Micro-Strip-Line-Fed Printed Wide-Slot Antenna With A Fractal-Shaped Slot[4]

Micro-strip-line-fed printed wide-slot antenna with a fractal- shaped slot for bandwidth enhancement is proposed and experimentally studied. Byetching the wides lot as fractal shapes, it is experimentally found that the operating bandwidth can be significantly enhanced, and the relation between the bandwidth and the iteration order (IO) and iteration factor (IF) of the fractal shapes is experimentally studied. Experimental results indicate that the impedance bandwidth, defined by 10 dB reflection coefficients, of the proposed fractal slot antenna can reach an operating bandwidth of 2.4 GHz at operating frequencies around 4 GHz, which is about 3.5 times that of a conventional micro-strip-line-fed printed wide-slot antenna. It also achieved a 2-dB gain bandwidth of at least 1.59 GHz.

E. Wideband Unidirectional Antenna of Folded Structure in Microwave System for Early Detection of Congestive Heart Failure[5]

A three-dimensional antenna based on a combination of loop and dual mono pole structures with parasitic elements is presented. The antenna is specifically designed for a microwave system aimed at the early detection of congestive heart failure. The antenna is first designed as a planar structure and then folded over optimally defined folding lines to properly alter the path and phase of the surface currents for a unidirectional radiation and compact size as needed for the detection system. A prototype antenna of size (where, is the wavelength of the lowest resonant frequency) is developed to cover the band required in the targeted application. The measured results indicate 53% fractional bandwidth (580 – 1000 MHz), 6-8 dB fronts to back ratio, and 3-5 dBi gain. The antenna is then used to build a heart failure detection system, which also includes a compact microwave transceiver, a processing and image reconstruction algorithm based on the synthetic aperture focusing technique, and a display unit. The system is used to successfully detect an early case of congestive heart failure in an artificial torso phantom that includes the main torso organs.

III. PROBLEM FORMULATION

From the literature survey analysis, the studies reveal that existing work shows the increased return loss, and VSWR. Gain total is also considerably needed to be increased. Frequency coverage is only for three frequency bands are generated.

The drawbacks present in the available antennas can be identified as Less reception of due to high return loss due to single patch antenna are used for each individual device.

Not compatible for future multiband antenna system applications. Each antenna requires each of them a separate processor to execute the particular data reception operation.

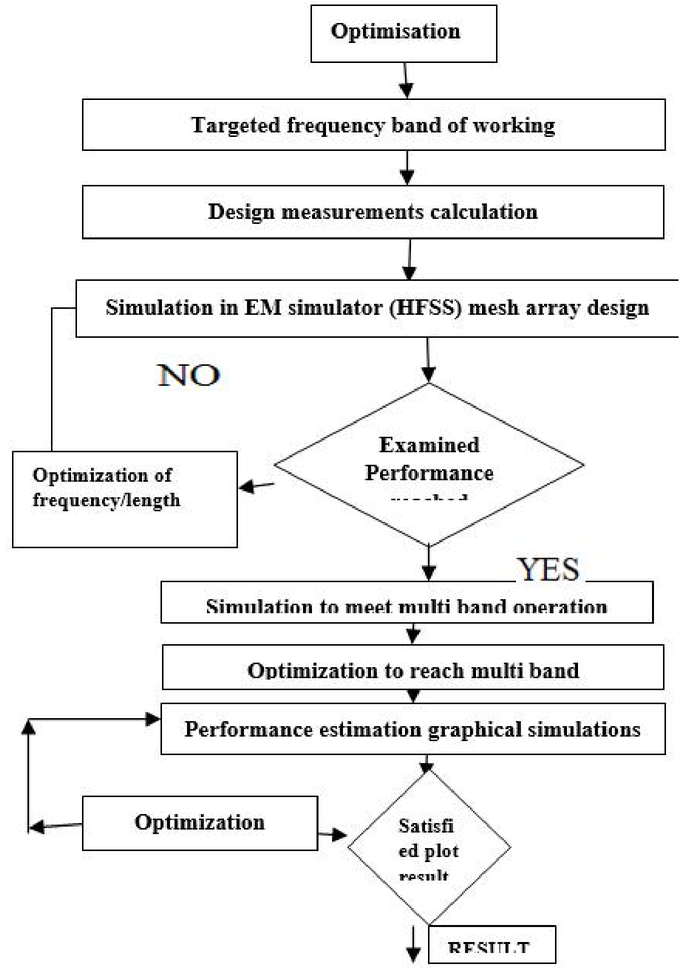
IV. OBJECTIVE

- To design a single band antenna for biomedical purpose.
- To achieve VSWR less than 2, to obtain optimum return loss and radiation pattern.
- To determine and compare the performance of micro-strip patch antennas with micro-strip feed line and coaxial feed line techniques.

V. PROPOSED WORK

The present work is about designing an antenna system to pick up the basic EEG and evoked potential of the brain at different activity levels. We intend also concentrating, initially, on the MRI, at the 2.7–2.9 GHz frequency band. The antenna system is designed to pick up the signals in such a manner that the signals are amenable for being processed. Incidentally we can analyze evoked potential also. We have done some initial analysis of the picked up signals in the Fourier domain and some of the results are presented. The amplitude and phase relations in the frequency domain on certain known conditions, especially in the occipital lobe are interesting. We would like to fine tune the antenna system and the software to detect tumors exploiting their differential morphology.

VI. DESIGN FLOW



VII. THE MICRO-STRIP PATCH ANTENNA

Proposed antenna is designed by using CST-Microwave Studio simulation software and all the important terms like reflection coefficient, SAR, current density is displayed. The antenna sizes are an important in the design process. Coaxial probe feeding reduces the spurious radiation occurred by other feeding method; hence it is applied to the design structure. Due to high *Q* leakage of the resonator, coaxial probing system depicts a restricted resonance bandwidth. Also, with the increment in probe length, the inductance along the line of probe becomes more effective which results in narrow bandwidth. By decreasing the length of the probe, this inductance can be controlled. The lower microwave frequency range highly depends on the overall dimension of the radiating structure. At the same time, the miniaturization of the antenna is limited by the frequency it is operating on. To achieve low frequency and miniaturization effectively, folding technique must be used. Fig. 1 exhibits the geometry of the antenna. The proposed structure is built at the center of a square shaped ground plane. To reduce the overall size of the antenna, a shorting wall is extended until the ground plane of the antenna [8, 9] which makes the antenna to resonate at a lower frequency. The width of the shorting wall is kept same as the radiating plane of the structure for simplicity. The lower patch is U-shaped and directly connected with the coaxial probe. The placement of the coaxial probe is crucial relative to the lower patch and optimized to achieve desired performance (not shown for brevity). To achieve decreased inductance at the operating frequency, the height of the probe is minimized.

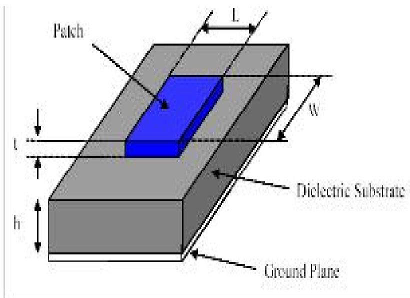


Fig 1: Structure Of Micro-Strip Patch Antenna

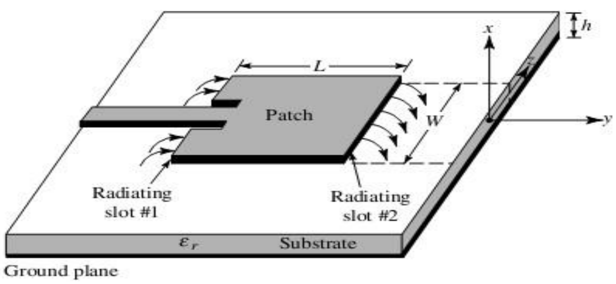


Fig 2: Micro-Strip Patch Antenna

VIII. DESIGN SPECIFICATIONS

The three essential parameters for the design of a slotted micro-strip patch are given below.

Frequency of operation (f_0): The resonant frequency of the antenna must be selected appropriately. For multiband operation the frequency range selected is from 0-10 GHz. Hence the antenna designed must be able to operate in this high frequency range. The resonant frequencies selected for our design are 2.7GHz.

Dielectric constant of the substrate (r): The dielectric material selected for our design is 'Air' which has a dielectric constant of 1.00059. A substrate with a low dielectric constant has been selected hence, it increased the bandwidth of the antenna.

Height of dielectric substrate (h): For the micro-strip patch antenna to be used in multiband applications, it is essential that the antenna is not bulky. Hence, the essential parameters for the design are

Frequency of operation (f_0) = 2.7 GHz.

Dielectric constant of the substrate (ε_r) = 2.2

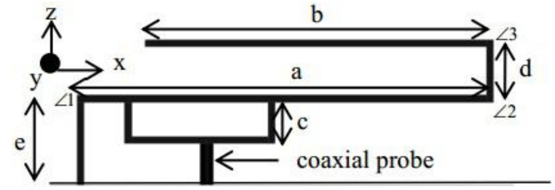


Fig 3: proposed antenna geometry

Fig 3 shows the proposed antenna which indicates the radiator fed with micro-strip feed line. The radiator consists of slot along with the feed in the in the radiating edge. These slots with the feed reduce the return loss to a greater extent.

The dimensions for the iterations are given as,

a =length of the patch
b =width of the patch
c = length of the patch
d = length of the patch
e= length of the patch

The proposed antenna is designed by cutting single patch to make it a patch antenna. Cutting of patches in antenna increases the current path which increases the current intensity, as a result efficiency is increased. The basic structure of antenna consists of ground plane, substrate, patch and feed line. The transmission line is the preferred method of analysis for calculating the various dimensions of the micro-strip patch antenna.

The transmission line model is applicable to infinite ground planes only. However, for practical considerations it is essential to have a finite round plane. It has been shown by that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater the patch dimensions by approximately six times the substrate thickness all-round the periphery

IX. CONCLUSION

A patch antenna in the radiator and partial ground plane has been designed and simulated. The proposed antenna exhibits five bands; it supports for 2.55 GHz, as well as good radiation properties. Therefore this antenna suitable for Super High Frequency application are other biomedical applications that works in these frequencies. Patch antenna for single band frequency applications with SISO technique is simulated.

REFERENCES

[1] B. J. Mohammed, A. M. Abbosh, S. Mustafa, and D. Ireland, "Microwave system for head imaging,"

Instrumentation and Measurement, IEEE Transactions on, vol. 63, pp. 117-123, 2014.

[2] Sabouni and A. Kishk, "Dual-polarized, broadside, thin dielectric resonator antenna for microwave imaging," Antennas and Wireless Propagation Letters, IEEE, vol. 12, pp. 380-383, 2013

[3] Li, M. Jalilvand, Y. L. Sit, and T. Zwick, "A compact double-layer on-body matched bowtie antenna for medical diagnosis," Antennas and Propagation, IEEE Transactions on, vol. 62, pp. 1808-1816, 2014.

[4] W.-L. Chen, G.-M. Wang, and C.-X. Zhang, "Bandwidth enhancement of a microstrip-line-fed printed wide-slot antenna with a fractal-shaped slot," Antennas and Propagation, IEEE Transactions on, vol. 57, pp. 2176-2179, 2009.

[5] S. Ahdi Rezaeieh, A. Abbosh, and Y. Wang, "Wideband unidirectional antenna of folded structure in microwave system for early detection of congestive heart failure," Antennas and Propagation, IEEE Transactions on, vol. 62, pp. 5375-5381, 2014.

[6] M. Kruesi, R. J. Vyas, and M. M. Tentzeris, "Design and development of a novel 3-D cubic antenna for wireless sensor networks (WSNs) and RFID applications," Antennas and Propagation, IEEE Transactions on, vol. 57, pp. 3293-3299, 2009.

[7] S. Ahdi Rezaeieh, A. Zamani, and A. Abbosh, "3-D Wideband Antenna for Head-Imaging System with Performance Verification in Brain Tumor Detection," IEEE Antennas and Wireless Propagation Letters, vol. 14, pp. 910- 914, 2015.

[8] K. Foster, J. Schepps, R. Stoy, and H. P. Schwan, "Dielectric properties of brain tissue between 0.01 and 10 GHz," Physics in medicine and biology, vol. 24, p. 1177, 1979.

[9] S. Gabriel, R. Lau, and C. Gabriel, "The dielectric properties of biological tissues: II. Measurements in the frequency range 10 Hz to 20 GHz," Physics in medicine and biology, vol. 41, p. 2251, 1996.

[10] A. Peyman, S. Holden, S. Watts, R. Perrott, and C. Gabriel, "Dielectric properties of porcine cerebrospinal tissues at microwave frequencies: in vivo, in vitro and systematic variation with age," Physics in medicine and biology, vol. 52, p. 2229, 2007.

[11] M. Jalilvand, X. Li, L. Zwirello, and T. Zwick, "Ultra wideband compact near-field imaging system for breast cancer detection," IET Microwaves, Antennas & Propagation, 2015.

[12] R. K. Amineh, M. Ravan, A. Trehan, and N. K. Nikolova, "Near-field microwave imaging based on aperture raster scanning with TEM horn antennas," Antennas and Propagation, IEEE Transactions on, vol. 59, pp. 928- 940, 2011.