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Stroke Diagnosis using Microstrip Patch Antennas Based on Microwave Tomography Systems

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ABSTRACT

Microwave tomography (MT) based on stroke diagnosis is one of the alternative methods for determinations of the haemorrhagic, ischemic and stroke in brain nervous systems. It is focusing on the brain imaging, continuous monitoring, and preclinical applications. It provides cost effective system and able to use the rural and urban medical clinics that lack the necessary resources in effective stroke diagnosis during emerging applications in road accident and pre-ambulance clinical treatment. In the early works, the design of microstrip patch antennas (MPAs) involved the implementation of MT system. Consequently, the MT system presented a few limitations since it required an efficient MPA design with appropriate parameters. Moreover, there were no specific diagnosis modules and body centric features in it. The present research proposes the MPA designs in the forms of diagnosis modules and implements it on the MT system.

Keywords: Microstrip patch antenna designs, microwave imaging systems, Debye test bed model, monostatic radar approach and UWB types of MPAs

INTRODUCTION

The brain stroke is the third major depth rate in the human society. It also causes serious long-term disabilities which lead significant economic impact. The current stroke diagnosis methods include computed tomography (CT), positron emission tomography (PET) and magnetic resonance imaging (MRI). The new non-invasive, mobile, real-time and easy to apply technique is microwave tomography (MWT). It is under development for diagnosis of breast cancer, lung cancer, brain imaging and cardiac imaging. Medfield diagnostics AB is an incubator company at Sahlgrenska hospital in Gothenburg, Sweden.

This goal of this project work is to design compact product for ambulances, so the proper stroke diagnosis can be made in earliest stage. The real-time diagnosis is important because of different treatment; the ischemic stroke patients are given thrombolytic treatment which could be fatal for haemorrhagic patients. Currently, two stroke diagnosis techniques are in development, statistical classification, and image reconstruction of human brain. The microwave based techniques need antennas which work in single or multi-frequency ranges. The multi-band operating systems are preferred due to higher resolution and deeper penetration than narrow band counterparts. This project focuses on design of ultra wide-band antenna (UWB) which is ideal for multi-frequency techniques.

The brain stroke is the third cause of death, ranking only behind heart disease and cancers. Therefore, the real-time diagnosis is important because of different treatment: the ischemic stroke patients are given thrombolytic treatment which could be fatal for haemorrhagic patients. The microwave based techniques for stroke diagnosis need antennas in single or multi-frequency ranges. The multi-band operating systems are preferred due to higher resolution and deeper penetration than narrow band counterparts.

Karanasiou, et al. [1] proposed on microwave radiometry system, determining the tissue temperature, conductivity distribution inside the human body. It offers the non-invasive microwave imaging system operating at 3.5 GHz for feasible brain intracranial applications. Romeu, et al. [2] investigated on 3D UWB magnitude combined tomographic algorithm which improved the robustness and image quality in multi-frequency operation. Ireland, et al. [3] proposed

wide band microwave imaging for the detection of a haemorrhagic stroke. The time domain function is used to estimate the back-scattered signals which are used in the image reconstruction process. Scapaticci, et al. [4] proposed image strategy based on modified formulation of the linear sampling method and is able to detect the quasi real time monitoring of the disease's evolutions. Semenov, et al. [5] investigated clinical brain imaging techniques. The nonlinear Newton reconstructive imaging method is presented in his work. It provides the deep reconstruction of brain imaging and able to operate multiple frequency ranges. The objective of brain imaging is located inside a high dielectric contrast shield, comprising the skull and CSF. Sudeb Das, et al. [6] proposed to differentiate the abnormal and normal magnetic resonance imaging of human brain which is obtained from support vector mechanism (SVM). In this research work offers the quality of MRI imaging techniques. Sidharath Jain, et al. [7] investigated the back scattered waveform to mapping of human brain using finite domain time difference (FDTD) mathematical modelling.

The above literature survey has been done in the imaging techniques through microwave tomography systems such as soft tissues diagnosis systems. The brain nervous system is able to determine the stroke as much as possible in microwave tomography system. The about literature survey from national authors is familiar interest to research in the following thrust areas, MRI imaging, back scattered wavelet transform, computer tomography based brain imaging systems and MPA design for stroke analysis, survey required. And also in the introduction different types of strokes may be defined. Hence, this article does not reflect from past literature survey.

A novel design of microstrip patch antennas for stroke analysis in the field of medicine diagnosis using microwave tomography systems is presented in this article. The main objective of this article is providing non-invasive, non-ionization applications microstrip patch antenna design which operate the Specific Absorption Ratio limitation under (1-10) GHz frequency ranges. The efficient microstrip patch antenna is designed by mathematical modelling. The antenna design is fabricated in monolithic intergraded circuits (MIC) and finally the performance is measured using Agilent microwave analyser with vector network analyzer (VNA-N19997A) and anechoic chamber test bed. It offers the compact size, omnidirectional radiation pattern with significant reduction in the radiation losses. In this antenna prototype makes the layered architecture which includes the ground plane, dielectric layer with significant dielectric constant and conductor plane. It covers wide band frequency ranges for detection of stroke in brain nervous system.

RESEARCH METHODOLOGY

The MPA prototypes with human head dielectric model have been validated on the existing Debye test beds. The prototype consists of a single transmitter and receiver MPA impressed with the coupling mediums that contact with the equivalent dielectric human head model. It is made up of homogenous dielectric materials. It has an equivalent dielectric constant vis-à-vis human brain nervous organ. The vegetable palm oils (εr=2.75) and the distilled water (εr=78) are selected for lower and higher dielectric constant respectively. Both the coupling materials interact separately with the test bed models. They produce good impedance matching between the ports. They provide the standard resolution of the stages and are described as haemorrhagic-I (<10% and >10), ischemic stroke-II (<20% to 22%), and stroke-III (>22% and >30). These three stages are considered as equivalent dielectric constant of 40-50 for three different asymmetrical dimension structures of 1 cm, 2 cm, 2.5 cm and 3 cm. Similarly, the dielectric head model consists of the wheat flour, sugar and glycerine dielectric materials.

They are considered the equivalent dielectric constants of the brain tissues, skin layers and blood content of the head organ. These three classes of brain dielectric material resolutions are included separately in the homogenous head model for conducting the existing Debye model. The scattering mapping algorithms are then used to determine the cancer resolution stages. The depth of scattered losses in the subtraction algorithm is deeper than the average scattered losses. It may be stated that this test bed gives perfectly determined stroke response and is more reliable with physical distance than the dielectric head model.

The present research works will be concluded, the depth of stroke have been detected using the existing Debye based test beds, coverage and vector dimensional parameters will be detected using monostatic radar approach and the pictorial image information about the haemorrhagic, ischemic and stroke will be analyzed using MVDR beamforming algorithms. The proposed targets of head resolution stages are more efficient than the existing diagnosis systems such as PET, CT, MRI and XRM. Finally, the present research concludes that the proposed the MPAs fabricate prototypes are suitable for stroke detection in UWB based MWT system.

The presented research work is designed for detecting the haemorrhagic, ischemic and stroke located in the brain nervous. The strokes are analyzed numerically as,

1) The depths of haemorrhagic, ischemic and stroke are presented in the brain nervous system is investigated with help of the proposed MPAs using the existing Debye based MPAs prototypes.
2) The coverage and vector dimensions of haemorrhagic, ischemic and stroke are located in the brain nervous system which is examined with the help of the proposed MPAs prototypes using the monostatic radar approach.
3) Finally, the present research extends to the determination of the stroke resolution stages using Minimum Variance Distortion Less Response (MVDR) beamforming algorithms.

This algorithm optimizes the weighted variable of direction of arrival (DOA) signals of the transceiver MPTs prototype with respect to the dielectric equivalent strength of the head model. Therefore, these test beds provide the sample pictorial representation of the target of brain nervous presented in the DOA of power spectral density (PSD) of the proposed MPTs prototypes. The horizontal slice lines appear in the DOA of PSD in the after beamforming algorithm. Hence, the sample pictorial representation is more efficient than the existing diagnosis methods such as MRI, XRM, PET and CT.

A novel technique for stroke diagnosis on brain nervous systems is proposed to this proposal. The advantage of using this method comes from the fact that it can be easily used for treatment planning with both sinusoidal and UWB pulse regimes. Moreover, the speed of the method is independent of the number of antennas, which makes the whole approach attractive to clinical use. In order to validate the feasibility of the proposed approach, the prototype is consisting of an antenna applicator and a wide band multi-channel system to steer it. In present stage, the clinical system for treatment tumours of head and neck (H&N) is under development. Due to the dismal prognosis of patients with advanced carcinomas in H&N accompanied by side effects of current methods, there is considerable clinical need for such a system. The current emphasis is on the development of UWB antenna applicator which provides safe and comfortable treatment.

In this proposed system will upgrade into a clinical prototype that will be used for stroke tests of patients. This proposed project is reconstructing images it has become clear that it is essential to base the image reconstruction algorithm on an accurate three-dimensional electromagnetic model of the antenna array. This will unfortunately make the computational burden very large. Earlier work with two-dimensional models is significantly more computational efficient but instead unable to generate images of sufficient accuracy and detail level. The test bed results obtained in this project proposal will be very valuable also in this research projects based on microwave technology.

CONCLUSION

The performance of the clinical system will be firstly examined on anthropomorphic phantoms. After successful evaluation, the similar microwave tomography (MWT) system is available for breast cancer detection application in Phase I. Patient Study at Sahlgrenska university hospital. In this proposed UWB antennas for detection of cancer tumours and also detection of tumours around antenna pattern. Finally, the cancer tumour will be obtained from imaging techniques. This similarity of cancer imaging is used in stroke diagnosis system and brain nervous image communicate through telemetry systems for health care applications. The stroke detection system will provide a way to improve the detection of haemorrhagic, ischemic and stroke. Whether it will replace or complement the MRI used today remains to be seen after the clinical evaluations. This examination will be painless, cost effective and the patient will not be exposed to ionizing radiation.

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