UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A MICROSTRIP U-SHAPE ANTENNA DESIGN FOR BREAST CANCER DETECTION

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

By

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DECLARATION

I hereby, declared this report entitled "A MICROSTRIP U-SHAPE ANTENNA DESIGN FOR BREAST CANCER DETECTION" is the results of my own research except as cited in references.

Signature   :   …………………………………..

Author's Name   :   …………………………………..

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

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(Project Co-Supervisor)

ABSTRAK

Pada masa kini, kanser payudara memberi kesan kepada kebanyakan wanita dan boleh mendatangkan maut sekiranya ia tidak dirawat dengan baik. Diagnosis awal adalah kaedah yang paling penting untuk membezakan dan mengetahui tisu kanser. Beberapa kaedah untuk mengenalpasti kanser payudara adalah X-ray mamografi, MRI dan ultrasound. Walau bagaimanapun, kaedah-kaedah tersebut mempunyai beberapa batasan. Sebagai contoh; sekitar 4 hingga 34% daripada semua kanser payudara terlepas kerana kaedah-kaedah tersebut tidak dapat membezakan tisu kanser yang berbahaya dengan yang tidak berbahaya. Pengimejan gelombang mikro untuk mengesan kanser payudara adalah satu kaedah yang menjanjikan. Semua bahan-bahan mempunyai pelbagai permitiviti dan kekonduksian. Dalam perkara ini, struktur payudara 3D mempunyai permitiviti yang tersendiri dan kekonduksian yang ditunjukkan dalam HFSS dengan menggunakan Finite Element Method (FEM) untuk menyelesaikan nilai medan elektromagnet dan antena mikrostrip tampalan yang beroperasi pada 2.45 GHz direka dan bahan substrat adalah FR4 (εr = 4.4 F / m). Dengan menukar parameter antena mikrostrip bentuk U, kuasa output akan berbeza. Tentang ini, jarak, dimensi dan sudut polarisasi antena dinilai.

ABSTRACT

These days, breast cancer affects numerous women and has fatal conclusions if the event that it does not cure effectively. Early diagnosis is the most essential methods to distinguish and meddle with cancer tissue. Some of methods for breast cancer recognition are X-ray mammography, MRI and ultrasound. However, they have a few limitations. For instance; somewhere around 4 to 34% of all breast cancers are missed due to poor harmful/generous cancer tissue contrast. Microwave imaging to recognize breast cancer is a promising method and there are many works here. All materials have diverse permittivity and conductivity. In this work, a 3D breast structure has distinctive permittivity and conductivity is demonstrated in HFSS by utilizing Finite Element Method (FEM) to solve electromagnetic field values and a microstrip patch antenna operating at 2.45 GHz is designed and substrate material is FR4 (εr = 4.4 F/m). By changing the parameters of the microstrip U-shape antenna, the output power will be different. About this, distance, dimension and polarization angle of the antenna are evaluated.

DEDICATION

Special dedication for:

To my beloved parents, Mr. Zamzuri bin Mohamed Thani and Mrs. Rokiah binti Ali
who always motivates me along the process of completing the project.

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I also would like to express my deep gratitude to both my parents, my siblings and Noor Amirah binti Azmi for supporting me even in a long ranges method. The inspiration and the motivation have pushed me to the best performance. Not to forget to my all friends that had been helping me to complete this project, Muhammad Syafwan bin Ismail, Muhammad Azrul Syafiq bin Suhaizam, Ahmad Faizuddin bin Mohammad, Muhammad Firdaus bin Azam, Muhammad bin Mohd Razib, Nik Muhamad Zikrillah bin Nik Yusoff, Muhammad Aniq Abdul Razak, Muhammad Syafiq bin Husin, Mohammad Nazryen bin Yacob and the others.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PCB   --   Printed Circuit Board

MH/HF   --   Medium Frequency/High Frequency

dB   --   Decibel

FSS   --   Frequency Selective Surface

DOE   --   Design of Expert

ADS   --   Advance Design System

CST   --   Computer Simulation Technology

SMA   --   SubMiniature Version A

ANOVA   --   Analysis of Variance

WLAN   --   Wireless Local Area Network

CHAPTER 1
Introduction

1.1 Background

Many women have been affected by breast cancer and has fatal conclusions if it does not cure correctly. One of the most important parameter to detect and interfere with cancer tissue is with an early diagnosis. There are some methods for breast cancer detection which are X-ray mammography, MRI and ultrasound. However, all of this method have some limitations. For example, between 4 and 34 % of all breast cancers are missed because of poor malignant cancer tissue contrast. One promising method that can be use is microwave imaging to detect breast cancer and there are many works in this area. All materials have different conductivity and permittivity. In this work, a 3D breast structure has different conductivity and permittivity is modeled in HFSS by using Finite Element Method (FEM) to solve electromagnetic field values and a microstrip patch antenna operating at 2.45 GHz is designed and substrate material is FR4 ($\dot{I}r = 4.4$ F/m). Slotting on microstrip patch and modifying ground plane, imaging quality is increased. Microstrip antennas are widely used in many practical applications because it has several advantages over conventional microwave antenna. It also consists of a radiating patch on one side of dielectric substrate ($\mathcal{E}r \leq 10$), which has a ground plane on other side. By changing the parameters of the microstrip U-shape antenna, the output power will be different. About this, distance, dimension and polarization angle of the antenna are evaluated.

1.2   Objective

1. To study and develop a microstrip U-shape antenna design for breast cancer detection.

2. To identify a significant effect of microstrip U-shape antenna parameter for breast cancer detection.

3. To optimize the best combine of microstrip U-shape antenna properties for optimizing the performance.

1.3   Problem statement

In according to cancer incidence statistics in 2012, 14.1 million people were diagnosed with cancer worldwide and 8.2 million people died from cancer. In Turkey, 97.000 men, 62.000 women and overall 159.000 people were diagnosed with cancer every year (Turkey Public Health Agency, 2012). There are many factors to affect this such as life-style, foods, contamination, stress and undefined things. Breast cancer is the most common cancer type among women. A lot of women suffer from this disease in the worldwide and have many unreturned problems because of not to diagnose early. The most important process before healing is early diagnosis. Early diagnosis has vital importance is reason to return life for many sufferers.

There are many methods to detect breast cancer such as X-ray mammography, ultrasound, tomography and MRI. However, they have some negative and undesired sides. Especially for younger women, these methods are not preferred because of ionized radiation. So, microwave imaging techniques are developed. Microwave imaging method for early diagnosis is rather interested and promising. Microwave imaging has more advantages such as low cost, more safety and easier availability. The working principle of microwave imaging

techniques is based on the dielectric contrast between the malignant tumor tissues and the healthy ones (Wang & Huang, 2012). The electrical properties as conductivity, permittivity or dielectric parameters of interesting tissue are used to pathological identify between normal breast cell and malignant tumor tissue through those contrast distribution maps (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). The basic idea of using microwave imaging system for breast cancer detection is to transmit electromagnetic waves from a transmitting antenna to the breast and receive the scattered waves at a receiving antenna (Mahalakshmi&Jeyakumar, 2012). Differences between electric field and magnetic field are important to identify cancerous tissue's position and volume etc. Thus, antenna choice plays an important role. Although there are several antenna kinds like horn, dipole, monopole etc., micro strip antenna has more advantages such as small structure, low cost, lightness and availability. To predict and optimize a radiating pattern of electromagnetic wave emitted from each antenna into tissue volume still be a key factor in microwave antenna system design especially both 2D plane and 3D space (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). There are lots of works for breast cancer detection about microwave imaging in literature. A study was investigated to detect breast cancer about microwave imaging (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). To detect cancerous breast tissue, (Wang & Huang, 2012) designed a MIMO antenna structure and evaluated microwave imaging results. To obtain microwave imaging by radiating into breast tissue, a single layer micro strip patch antenna structure was designed (Mahalakshmi&Jeyakumar, 2012).

1.4   Scope of work

In this paper, inset fed antenna structure as a microstrip antenna is used for the purpose of microwave imaging over detecting cancerous tissue into breast structure and so, a simple 3D breast structure is modeled to define cancerous

tissue. 3D breast structure is designed by inspiring from the reference (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). All simulations are implemented in HFSS by using Finite Element Method (FEM). ISM band which is used commonly is preferred for investigation. In this work, better simulation results are obtained by modifying ground plane and slotting on microstrip patch. The antenna structure operating at 2.45 GHz is placed under breast skin and differences between electromagnetic field values according to simulations results are evaluated. There are three properties that will be highlighted which are dimension, distance and polarization angle.

CHAPTER 2
Literature Review

2.1 WLAN

Wireless communications are breaking the bonds Internet clients have needed to wired associations. Versatility while getting to the Internet and expanded adaptability are persuading the remote system innovation push. Likewise, Wireless Local Area Networks (WLANs) can even (now and again) be more sparing and proficient than introducing wired systems all through a building. With the business sector advancement of wireless network technologies, administrations and applications are expanding regular. Be that as it may, the development of the WLAN market and administrations likewise depends on the arrangement and control of every nation. A free direction may quicken the development of WLAN market additionally makes impedance issues. By differentiation, strict controls could distribute the range well however may obstruct market advancement(Yeh et al. 2003).

Wireless network technologies were uninteresting (and juvenile) for a long time until 1985 when the Federal Communications Commission (FCC) of the United States approved the Industrial, Scientific and Medical (ISM) recurrence groups. These three ISM groups quickened the advancement of WLANs since merchants no more expected to apply for licenses to work their items. In 1989, the IEEE 802.11 Working Bunch started explaining on the Wireless LAN Medium Access Control what's more, Physical Layer specifications. The last draft was endorsed on 26 June 1997(Yeh et al. 2003).

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The IEEE 802.11 standard indicates distinctive radio frequency (RF) physical layers basically working at the 2.4 GHz ISM band: Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS). The DSSS physical layer gives 2 Mbps of crest rate and discretionary 1 Mbps into a great degree boisterous situations. On the other hand, the FHSS physical layer works at 1 Mbps with discretionary 2 Mbps in clean situations. Notwithstanding the RF physical layer, an infrared (IR) physical layer is moreover indicated. The IR physical layer underpins both 1 Mbps and 2 Mbps for getting, furthermore, 1 Mbps with a discretionary 2 Mbps bit rate for transmitting. The IR physical layer utilizes the reflected infrared vitality for interchanges, which is called diffuse infrared transmission, such that the transmission is not coordinated. The commonplace scope of 10 m to a great degree limits IR remote frameworks. The correspondence quality is likewise delicate to nature (e.g. the quantity of reflecting surfaces furthermore, observable pathway ways). Along these lines, sellers generally receive the RF systems as opposed to the IR framework(Yeh et al. 2003).

Like different wireless standards, security is a standout amongst the most basic issues. In the first IEEE 802.11 standard, a Wired Equivalent Privacy (WEP) calculation was received to scramble messages. Wired Equivalent Privacy (WEP) calculation was received to encode messages. WEP utilizes a RC4 (Rivest Cipher 4) pseudo-irregular number generator (PRNG) calculation with two key structures of 40 furthermore, 128 bits(Yeh et al. 2003).

In the second from last quarter of 2002, the equipment shipment of 802.11b developed by 24% and keeps on overwhelming the WLAN market. Then again, the end-use incomes expanded just eight percent on the grounds that the cost of WLAN items dropped radically concurring to the Reed Hardware Group. With the promotion of WLAN items, community WLAN administrations are springing up all around the world. Various WLAN administrators are giving different administrations in air terminals, inns and bistros(Yeh et al. 2003).

2.2   Basic antenna design

In this work, inset fed antenna structure as a rectangular microstrip patch antenna is utilized. Fig. 2 indicates proposed receiving wire structure and the names of its measurements. FR4 (Ir = 4.4 F/m) is utilized as substrate material. Substrate measurement x is 65.4 mm, y is 88.99 mm and substrate thickness is 1.588 mm. Patch measurement x is 37.26 mm, y is 28.83 mm. Inset separation and inset hole are 9.574 mm and 1.518 mm, separately. Nourish length is 27.958 mm and food width is 3.036 mm. The proposed receiving wire is set under the bosom structure, which is appeared in Fig. 3. As per configuration in Fig. 3, reenactments are actualized(Çalışkan et al. 2015).

Figure 2.1   Basic 3D Breast Structure

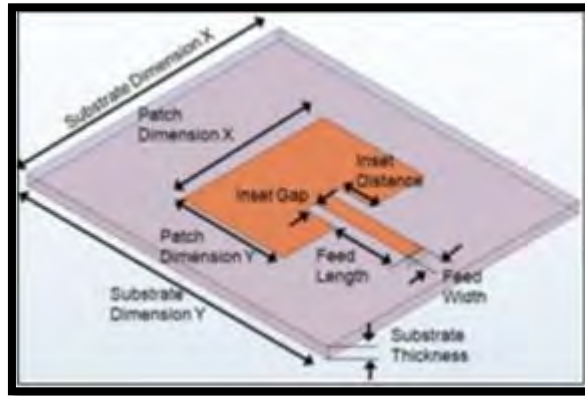| Table 1. Dielectric and conductivity values of breast tissue		
Tissue type	Dielectric (ε)	Conductivity(σ)
Normal breast tissue	9	0.4
Breast skin	36	4
Cancerous breast skin	50	4

Figure 2.2   Proposed Antenna Structure

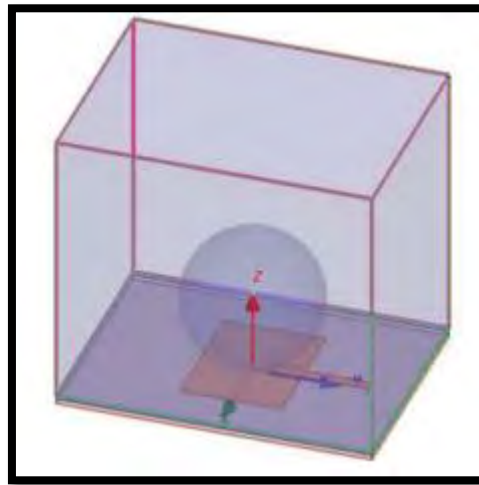Figure 2.3   Design With Proposed Antenna And Breast Structure

2.3   Basic breast structure

Female breast structure in this work is displayed as an essential breast structure which is appeared in Fig. 1. The measurements of ordinary bosom tissue are chosen as "65.4x88.99x80 mm3". The measurements of bosom skin are chosen as "65.4x88.99x1 mm3" and bosom skin is set under the typical bosom

tissue. Destructive bosom tissue is demonstrated as a round structure and is put into the ordinary bosom tissue. Its span is chosen 20 mm for recreations. When all is said in done, a communication of microwave proliferation in body living tissue worried with an electrical field is regarded to two fundamental dielectric properties as permittivity (I) and conductivity (ı) (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). Permittivity and conductivity change from materials to materials and these progressions are utilized to assess electric field and attractive field values in the diverse structures. Structures have diverse permittivity and conductivity values have distinctive electromagnetic field values. This parameter assumes a critical part to recognize destructive tissue. Table 1 demonstrates that permittivity and conductivity estimations of essential bosom structure (Sanpanich, Phasukkit, Tungjitkusolmun, &Pintavirooj, 2011). Permittivity and conductivity estimations of destructive bosom tissue are 50 (F/m) and 4 (S/m) while permittivity and conductivity estimations of ordinary bosom tissue are 9 (F/m) and 0.4 (S/m), individually(Çalışkan et al. 2015).

2.4 Breast cancer

Breast cancer is cancer that develops from breast tissue. Indications of breast cancer may incorporate a protuberance in the breast, an adjustment fit as a fiddle, dimpling of the skin, liquid originating from the areola, or a red layered patch of skin. In those with far off spread of the sickness, there might be bone torment, swollen lymph hubs, shortness of breath, or yellow skin.

Dangerous cell in mammalian organ or breast cancer is one of the real wellbeing risks to lady for quite a while back. This lethal tumor is regularly found in moderately aged ladies everywhere the world particularly in the western nation. This destructive marvel in her gland is still expanded significantly every year. Numerous components were guaranteed as a current cause, for example, sustenance, sullying, way of life furthermore unidentified cases. Taking after with

numerous effects to a personal satisfaction of her claims furthermore her relative family. It was realized that to identify any anomaly area in a prior state or in a kind state as before long as could be allowed is the best reasonable approach to handle with this issue(Sanpanich et al. 2012).

Although not at all like melanoma, breast cancer is not for the most part seen as a very immunogenic disease, late studies have depicted a rich tumor invulnerable microenvironment in a subset of breast cancer. These invulnerable invades, contained cells from the inborn and versatile safe reaction, can be recognized and described in biopsy examples and have prognostic quality. Tumor-invading lymphocytes (TILs) speak to the dominant part of mononuclear invulnerable penetrates in the breast cancer microenvironment and can be effortlessly distinguished in formalin-settled paraffin-implanted tissues after standard hematoxylin and eosin recoloring. Large amounts of TILs are most normal in HER2+ and basal-like subtypes where they are connected with great visualization and with reaction to specific treatments, for example, the counter HER2 immunizer trastuzumab. Worldwide community oriented endeavors are in progress to institutionalize the evaluation of TILs in order to encourage their execution as a breast cancer biomarker. Utilizing immunohistochemistry to advance portray TILs, late reports depict the nearness of vital lymphocyte populaces including CD8+ cytotoxic, FOXP3+ administrative, and CD4+ aide and follicular T cells which have covering relationship with guess and reaction to treatments. Besides, as of late distinguished invulnerable checkpoint markers (PD-1, PD-L1) are available in some breast cancer, suggesting some cases may be particularly amiable to safe checkpoint inhibitor treatment techniques which are being assessed in various dynamic clinical trials(Burugu et al. 2016).

There are several risk factors that can develop breast cancer such as parity, breast feeding, alcohol, obesity, diet, physical activity, oral contraceptive use, HRT and tobacco. Parous ladies have a lessened danger of breast cancer disease looked at with nulliparous ladies; this assurance takes after a transient increment

in danger (contrasted and nulliparous ladies) in the 10–20 years taking after delivery. Because the choice to have kids or not is dictated by numerous contemplations (which are unrealistic to incorporate a longing to lessen the danger of breast cancer), parity was not viewed as further as a modifiable way of life danger element, however age at first birth was considered. There is a relationship between age at first birth and breast cancer. Women first conceiving an offspring after the age of 35 years have a 40% expanded danger contrasted and ladies first conceiving an offspring before the age of 20 years(Hayes et al. 2013).

Augmented breast-feeding is defensive against breast cancer. It is assessed that the relative danger of breast cancer diminishes by 4.3% (95% CI 2.9–5.8) for each 12 months of breast feeding, however it is recognized that ladies coming back to the examples of childbearing and breast feeding that embodied most social orders until a century on the other hand so back is unrealistic. Given that this defensive impact is generally unassuming with regards to a practically modifiable impact (Hayes et al. 2013).

Alcohol admission is connected with an expanded danger of bosom cancer,21–23 with higher dangers for ladies who drink intensely. Contrasted and ladies expending no liquor, the relative danger for breast cancer disease for an admission of 35–44 g (3–5 beverages) every day was 1.3 (1.2–1.5)(Hayes et al. 2013).

The relationship amongst obesity and the danger of breast cancer contrasts for pre-menopausal and post-menopausal ladies. In premenopausal ladies, most studies have discovered either no or a frail reverse relationship between body mass record (BMI) (weight in kilograms separated by the square of tallness in meters) and breast cancer risk. For post-menopausal ladies, the danger of creating breast cancer is roughly 30% higher in the event that they have a BMI more than 30 contrasted and ladies with a BMI of 22.5–24.9(Hayes et al. 2013).

Reports of a relationship amongst diet routines and breast cancer are conflicting. Forthcoming studies, including a few intercessions ponders, have not discovered steady proof of any relationship between dietary elements and breast cancer. This implied eating regimen was not considered further as a modifiable danger component for breast cancer(Hayes et al. 2013).

Absence of physical activity is connected with an expanded danger of breast cancer. The defensive relationship between physical activity and breast cancer appears to be free of BMI, and a survey by the International Agency for Research on Cancer reasoned that the affiliation is causal. Physical activity has been recognized as one way ladies could decrease their danger of creating breast cancer. There is a 30% expansion in the danger of breast cancer for stationary ladies contrasted and dynamic ladies(Hayes et al. 2013).

Present and late clients of oral contraceptives have a 24% expansion in the danger of breast cancer contrasted and never clients, however this decays after ceasing use, with no overabundance hazard 10 years from last use(Hayes et al. 2013).

HRT is connected with an expanded danger of breast cancer. Use for a long time or more builds the danger of breast cancer by around 35%, with the danger coming back to typical 5 years subsequent to ceasing HRT. There is a 66% expanded danger of breast cancer for ebb and flow utilization of HRT contrasted and the not utilized class(Hayes et al. 2013).

There is practically no influential proof that tobacco smoking is connected with breast cancer risk. The absence of persuading proof for a relationship between smoking and breast cancer implied that smoking was definitely not considered further as a danger variable for breast cancer (Hayes et al. 2013).