National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Design and Analysis of Miniaturized Antennas for Breast Cancer Detection
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Venue	: BM Departmental Seminar Room BM-140
Date and Time	: 16 Jun 2025 (11:00 AM)

Abstract : Breast cancer is one of the major health concerns faced by most women across the world. After lung cancer, it is the second most common cause of death. There are an estimated 685,000 deaths occurred in the year 2023 due to breast cancer, according to the reports of the World Health Organization (WHO) and the Global Cancer Observatory (GLOBOCAN). So, there is an urgent need to improve diagnostic technology for the early detection of breast cancer to improve the survival rate of the patient. This work focuses on designing different compact antennas for electromagnetic imaging systems for high-resolution images in breast cancer diagnosis. This study different antenna configurations, such as slotted patch arrays, ultra-wideband (UWB) antennas, graphene-integrated monopoles, and hybrid graphene-gold tunable microstrip patch antennas to achieve high-resolution imaging and efficient and early tumour detection. These designs address significant challenges in medical imaging, such as penetration depth and resolution at microwave frequencies and in the Terahertz regime.

In microwave frequency range an efficient method for high-resolution microwave imaging for early-stage breast cancer detection using ultra-wideband (UWB) antenna is designed. A compact UWB decagonal monopole antenna, designed through a step-by-step evolution process, is proposed as the front-end device for the microwave imaging system. The antenna exhibits a fractional bandwidth of 138.06%, a peak gain of 6.18 dBi, and an average efficiency exceeding 90%. In this work, a 3D breast phantom is numerically modeled using CST Microwave studio. Subsequently, an UWB antenna is then used to scan the breast phantom at 36 different positions. S11 parameters are collected in both configurations, i.e., with and without a tumor inside the phantom. These parameters are then used to generate a high-resolution 2D microwave image of the breast using confocal microwave imaging (CMI) algorithm to detect the tumor. The designed antenna exhibits a specific absorption rate (SAR) of 1.22 W/kg at 13.08 GHz, which is within safe limits for human exposure. Hence the proposed UWB antenna is found to be a suitable candidate for biomedical applications.

A key innovation of this work is a tunable proximity-coupled microstrip patch antenna (TPCMPA) with a reconfigurable frequency response, achieved by dynamically varying the graphene's chemical potential (&muc). This adjustment is facilitated through an integrated DC biasing network, enabling real-time adaptation to different breast tissue characteristics. The proposed antenna combines the low-loss characteristics of gold with the tunability of graphene, achieving a peak gain of 4.21 dBi and radiation efficiency of 69.4%. The design evolution systematically integrates graphene strips and a DC biasing network to enable frequency reconfigurability. This work advances THz antenna technology by offering a high-performance, reconfigurable solution for next-generation biomedical imaging and communication systems.

Keywords: Breast Cancer Detection Ultra-Wideband (UWB) Antenna Terahertz (THz) Imaging Graphene-Based Antennas Microwave Imaging (MWI) Tunable Antenna