Chapter 8
Performance Analysis of SSRR in High-Speed Terahertz Antenna for Biomedical Applications

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ABSTRACT

Breast cancer is the most prevalent type of cancer causing 1 of 8 cancer diagnoses globally. In the year 2020, there were approximately 2.3 million newly diagnosed cases and 0.685 million deaths from this disease. In order to avoid these, it is mandatory to detect breast cancer in the early stage. In breast cancer detection, terahertz (THz) technology is a promising technology that will not affect the skin due to heavy radiation and offers enhanced breast detection capability. The proposed THz antenna is based on a square-shaped split ring resonator (SRR) which helps to detect the tumor in the breast of the woman. The proposed square SRR antenna resonates at 2 THz with a return loss of -66.55 dB as the maximum and a VSWR of 1.0005. The square SRR structure produced the maximum gain of 8.721 dBi with 8.734 dB directivity. The designed antenna is suitable for biomedical fields such as detecting tumors, body scanner, and various THz applications.

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INTRODUCTION

Breast cancer is a type of cancer that occurs in the breast cells. It can affect both genders, but it impacts women far more frequently than men. Breast cancer symptoms and warning indicators may include a tumour in the breast that senses distinct from the nearby tissue, variation in breast shape and size, changes in breast skin, peeling, redness, etc. To help women's society, it is necessary to reduce the effect of breast cancer in earlier stages with the aid of digital technology. The research towards finding a more accurate detection of breast tumors in earlier stages is very important and helps save the patient's health.

In order to enhance the diagnosis of tumors, the SRR-based THz antenna improves the accuracy as well as the efficiency in detecting the tumor in the breast. THz radiation (Sivasangari et al., 2023, Ponnupillai et al., 2023) used for detecting breast cancer ranges from 0.3 to 3 THz. THz radiations have a scattering loss and higher depth of penetration which does not affect the human body's soft tissues (Byrne et al., 2011, Yu et al., 2011, Porter et al., 2013, Zhang et al., 2011, Ouerghi et al., 2017). The actual frequency of the THz in terms of Hz is 10^{12} Hz or 1000 GHz. In the THz band, the radiation wavelength equivalently ranges from 1 mm to 0.01 mm. Though the THz radiation begins at the wavelength of 1mm and designates as shorter wavelengths. The bands in which the electromagnetic waves are radiating are regarded as far-infrared. As the THz radiation is absorbed by the atmosphere gases, the air is attenuated to 0 within a few meters; therefore, it is unsuitable for radio and wireless communication. The radiation can penetrate deeply into thin layers of the materials but it is obstructed by thicker objects. An inspection of layers is used as the replacement for the x-rays for producing higher resolution images in the interior of heavy solid objects (Truong et al., 2015). This radiation takes place amongst the ultraviolet waves and microwaves denoted as the THz gap.

Generally, the signals are processed through space in the form of electromagnetic waves comprising electric and magnetic fields fluctuating perpendicular to one another and to the axis of the wave's travel. The swiftness of electric charges, such as electrons, produces these EM waves. The classification of EM spectrum existence is based on frequency or wavelength. The EM waves travel at the speed of light and the wave properties are described by maxwell's equation. Antennas convert electromagnetic waves into the form of voltage and current and vice versa for the transmission and reception process.

The microstrip patch antenna is more advantageous because it is flexible and miniature in its size. In a microstrip square patch antenna, the lesser gain and efficiency can be overcome by introducing the photonic crystal in it (Britto et al., 2022, Kumar et al., 2020, Kumar et al., 2021). The substrate which has high permittivity produces less efficiency as it couples the power with surface waves. Therefore, to eliminate