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Design of a Novel UWB Microstrip patch antenna for Breast Cancer detection

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defected ground structure and optimized

ABSTRACT

Breast cancer is one of the most common and life-threatening diseases affecting women worldwide, and early detection plays a vital role in reducing mortality rates. Conventional diagnostic techniques such as mammography, ultrasound, and MRI suffer from limitations including high cost, radiation exposure, discomfort, and reduced accuracy in dense breast tissues. To overcome these challenges, microwave imaging using Ultra-Wideband (UWB) antennas has emerged as a promising non-invasive and safe diagnostic approach. This project presents the design of a novel UWB microstrip patch antenna specifically developed for breast cancer detection applications. The proposed antenna operates over a wide frequency range, enabling high-resolution imaging of breast tissues. The compact size, low profile, and ease of fabrication make it suitable for wearable and medical imaging systems. A

patch geometry are employed to enhance bandwidth and radiation performance. The antenna exhibits stable radiation patterns, low return loss, and acceptable gain across the UWB spectrum. Simulation results demonstrate effective penetration and sensitivity to dielectric variations in breast tissues. The proposed design proves to be a cost-effective and patient-friendly solution for early breast cancer diagnosis.

INTRODUCTION

Breast cancer detection at an early stage significantly increases the chances of successful treatment and survival. Traditional imaging methods such as X-ray mammography expose patients to ionizing radiation and often cause discomfort during screening procedures. Moreover, these methods may fail to detect tumors in dense breast tissues. Microwave imaging has gained attention as a safe and non-ionizing

alternative for breast cancer diagnosis. This technique relies on the contrast in dielectric properties between healthy and malignant tissues. Ultra-Wideband (UWB) antennas are a key component of microwave imaging systems due to their wide frequency range and high temporal resolution. Microstrip patch antennas are widely preferred because of their compact size, lightweight structure, and compatibility with planar fabrication techniques. In medical applications, antenna performance parameters such as bandwidth, radiation pattern, and impedance matching are crucial. The design of a novel UWB microstrip patch antenna optimized for breast cancer detection is therefore essential. This project focuses on developing a compact UWB antenna capable of accurately detecting abnormalities within breast tissues. Simulation-based analysis is carried out to evaluate antenna performance for medical imaging applications.

LITERATURE SURVEY

Several researchers have explored the use of UWB antennas for breast cancer detection using microwave imaging techniques. Early studies demonstrated that malignant tissues exhibit higher dielectric constants compared to normal breast tissues. Researchers proposed monopole and Vivaldi antennas

due to their wide bandwidth characteristics. However, these antennas often suffer from large size and complex feeding mechanisms. Microstrip patch antennas were later investigated for medical imaging due to their low profile and ease of integration. Various slot-loaded and fractal patch designs were introduced to improve bandwidth performance. Defected ground structures (DGS) have been widely used to enhance impedance bandwidth and reduce surface wave losses. Some studies employed wearable antenna designs to enable continuous monitoring of breast tissues. UWB antennas integrated with breast phantoms were simulated to study wave penetration and tumor detection capability. Researchers also focused on reducing Specific Absorption Rate (SAR) to ensure patient safety. Dual-polarized and circularly polarized antennas were proposed to improve imaging accuracy. Despite these advancements, challenges such as limited gain, mutual coupling, and fabrication complexity remain. Hence, there is a need for a novel UWB microstrip patch antenna that offers compact size, wide bandwidth, stable radiation, and suitability for breast cancer detection systems.

EXISTING SYSTEM

The existing breast cancer detection systems primarily rely on imaging techniques such

as mammography, ultrasound, and MRI. Mammography uses X-ray radiation, which poses health risks when used frequently. Ultrasound imaging provides limited resolution and is highly operator-dependent. MRI offers high accuracy but is expensive and not easily accessible in developing regions. Microwave imaging systems using conventional antennas face challenges such as limited bandwidth and poor impedance matching. Some existing UWB antenna designs are bulky and unsuitable for wearable medical devices. Additionally, high fabrication complexity increases the overall system cost. In certain designs, radiation patterns are unstable across the operating band, affecting imaging quality. Mutual coupling between antenna elements also degrades system performance. SAR levels in some antenna systems exceed recommended safety limits. Therefore, existing systems lack a compact, cost-effective, and patient-friendly antenna solution for efficient breast cancer detection.

PROPOSED SYSTEM

The proposed methodology involves designing a novel UWB microstrip patch antenna optimized for breast cancer detection. The antenna is designed using a suitable dielectric substrate to achieve compact size and wide bandwidth. Patch

geometry modifications and slotting techniques are applied to enhance impedance matching. A defected ground structure is incorporated to improve bandwidth and radiation efficiency. The antenna is simulated using electromagnetic simulation software to analyze parameters such as return loss, VSWR, gain, and radiation pattern. A breast phantom model is used to study wave penetration and tumor detection capability. Dielectric contrast between healthy and cancerous tissues is analyzed. SAR analysis is performed to ensure patient safety. The antenna performance is evaluated across the UWB frequency range. The proposed design aims to achieve stable radiation, low return loss, and compact dimensions suitable for medical imaging applications.

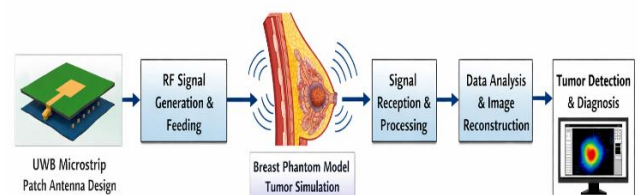
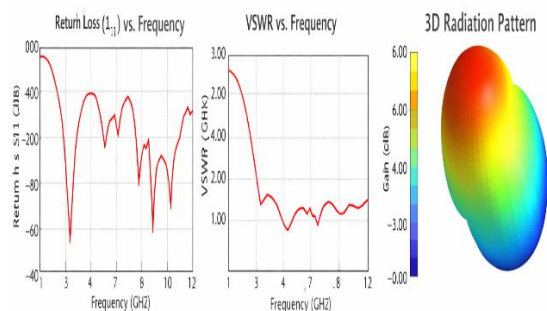


Fig:1 UWB Microstrip patch antenna for Breast Cancer detection

The system begins with the UWB microstrip patch antenna, which is designed to transmit ultra-wideband microwave signals. An RF signal generation and feeding unit supplies the required excitation to the antenna. The antenna radiates UWB signals toward the breast phantom model

representing human breast tissues. Due to dielectric contrast, cancerous tissues reflect signals differently compared to healthy tissues. The scattered and reflected signals are captured by the receiving antenna. The received signals are sent to the signal reception and processing block. Noise reduction and time-domain analysis are performed on the collected signals. Processed data is forwarded to the image reconstruction module. Microwave imaging algorithms generate a visual representation of tissue abnormalities. Finally, the tumor detection and diagnosis block identifies the presence and location of cancerous

RESULTS AND DISCUSSION



The proposed UWB microstrip patch antenna was simulated using electromagnetic simulation software to evaluate its performance for breast cancer detection applications. The return loss (S₁₁) characteristics show that the antenna operates effectively over the UWB frequency range, with S₁₁ values

remaining below -10 dB, indicating good impedance matching. Multiple resonance points are observed, which contribute to wide bandwidth operation. The VSWR plot confirms efficient power transfer, as the VSWR values remain below 2 across the operating band. This ensures minimal signal reflection and improved antenna efficiency. The radiation pattern demonstrates stable and near-omnidirectional behavior, which is suitable for microwave imaging applications. Adequate gain is achieved across the UWB range, enabling sufficient penetration into breast tissues. The radiation characteristics remain consistent over different frequencies, ensuring reliable imaging performance. The wide bandwidth improves spatial resolution in detecting tumors. Overall, the simulation results validate that the proposed antenna meets the requirements for non-invasive breast cancer detection. The antenna is therefore suitable for integration into microwave imaging-based diagnostic systems.

CONCLUSION

In this project, a novel UWB microstrip patch antenna for breast cancer detection has been successfully designed and analyzed. The proposed antenna offers wide bandwidth, compact size, and stable radiation characteristics, making it suitable

for microwave imaging applications. Simulation results demonstrate effective impedance matching and acceptable gain across the UWB spectrum. The antenna shows good penetration capability and sensitivity to dielectric variations in breast tissues. The use of a defected ground structure enhances overall performance. The proposed design provides a safe, non-invasive, and cost-effective solution for early breast cancer detection. This antenna can be further developed for real-time clinical applications and wearable diagnostic systems.

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