Non-Invasive Microwave Reflectometry for Skin Cancer Detection: Simulation of A Multi-Layer Tissue Model

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Skin cancer is one of the most fatal and prevalent forms of cancer worldwide [1]. Notably, Australia records one of the highest global rates of skin cancer [2]. The number of deaths can be reduced if skin cancer is detected as early as possible [3]. In this regard, the diagnostic capabilities of dermatologists can be improved by computer-aided techniques. Therefore, there is a pressing need to provide computer-aided cancer detection solutions in the early stages. This not only supports healthcare professionals in quick and accurate diagnosis but also contributes to bridging existing research gaps in this field. Fig. **1** illustrates three types of skin cancer including squamous cell carcinoma (SCC), basal cell carcinoma (BCC), and malignant melanoma. Starting from these considerations, this work presents a microwave reflectometry-based technology that can be applied as a non-invasive method to identify biological abnormalities in early stages, such as skin cancer. This system relies on the dielectric differences existing between normal and abnormal biological tissues at microwave frequencies.

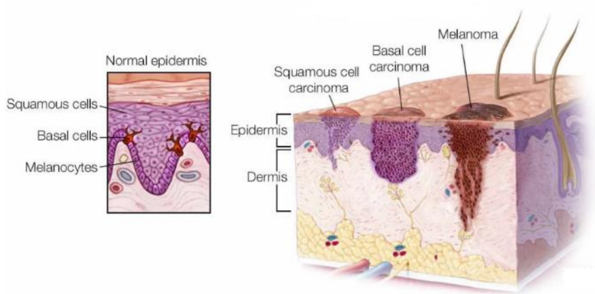

Fig. 1: Types of skin cancer, including squamous cell carcinoma (SCC), basal cell carcinoma (BCC), and melanoma [4].

In this study, we propose a human tissue model and conduct a full-wave electromagnetic (EM) simulation to investigate the interaction of EM waves with normal and cancerous human skin models. Our approach involves a three-layer biological tissue model, comprising dry skin with cancerous lesions, fat, and muscle layers, in conjunction with a waveguide probe. The simulations are performed using CST Studio Suite software. The ultimate goal is to determine whether the observed skin spot is suspicious for cancerous cells or not. As shown in **Fig. 2**, the simulation results demonstrate the model's capability to discriminate between unhealthy lesions and healthy skin, regardless of their position, stage, or the portion of the cancerous lesion that is under-tested.

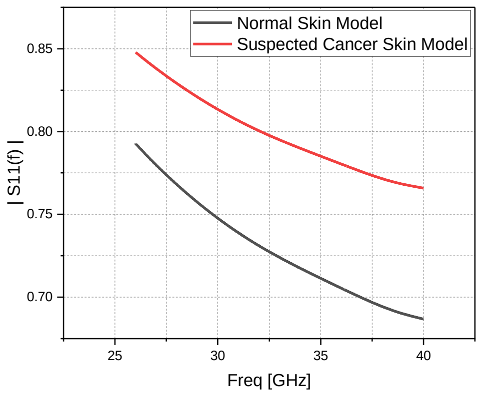

Fig. 2: Simulated scattering parameter of the modelled biological tissue. Magnitude response.

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