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A Dielectric Rod Antenna for Medical Diagnosis

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Summary

In this abstract, some common requirements in designing an antenna for biomedical diagnosis such as bandwidth, penetration depth, compactness and interference susceptibility are reviewed. A Dielectric Rod Antenna is presented that is designed to fulfil the aforementioned requirements.

Over the past few years, microwave imaging has gained considerable attention in medical diagnosis. Stroke diagnosis [1], breast cancer detection [2] and muscle loss diagnosis [3] are a few examples. In all these examples, antennas play an essential role in detection accuracy. Several requirements need to be considered in designing an antenna for biomedical diagnostics applications to attain high detection accuracy. To list a few, we can refer to:

- **Bandwidth:** The bandwidth of an antenna is characterized by the range of frequencies where the reflection coefficient of the antenna falls below -10 dB. In biomedical diagnostics, the goal is to have an ultra-wideband antenna that can operate at a large range of frequencies that enables high-resolution diagnostics [4].
- **Deep Penetration into the Tissue:** As the attenuation of the microwaves inside a lossy environment like biological tissues increases with the frequency of the signal, it is desired to operate in lower frequencies to ensure enough penetration of the wave to internal organs [5].
- **Compactness:** In a microwave-based biomedical diagnosis system several antennas are commonly placed around the body [6, 7]. Therefore, the antenna's physical size should be small enough.
- **Interference Susceptibility:** One problem of on-body antennas is the existence of surface or creeping waves [8]. A part of the radiated wave travels on the surface of the body and is then received by the adjacent antennas, interfering with the direct-path wave and deteriorating the diagnosis accuracy [9]. Therefore, the goal is to mitigate this multi-path signal.

It's challenging to design an antenna that possesses all the above-mentioned features as attaining one can result in losing the other. For example, an antenna that operates at low frequencies is physically large, therefore it hinders compactness. Additionally, reaching a wide bandwidth at low frequencies is challenging [10]. A way to tackle the creeping wave challenge while maintaining the matching between the antenna and the body is to move away the radiating element from the body and guide the radiated wave toward it. This is done by designing a Dielectric Rod Antenna is proposed. The antenna is composed of a radiating element, a Self-Grounded Bow-Tie Antenna (SGBTA) [11], and a two-layer dielectric rod as shown in Fig. 1. It is shown that the proposed antenna design increases the bandwidth by 71%, stabilises the near-field gain, and decreases the power of the waves propagating on the surface up to 10 dB, all in comparison with SGBTA. The penetrations depth of the antenna has not changed in comparison with SGBTA while the near-field radiation pattern has been narrowed. The dimensions of the Dielectric Rod Antenna are $(0.26 \times 0.18)\lambda_0$ at 700 MHz and is a compact antenna.

The designed Dielectric Rod Antenna with the above-mentioned characteristics is a suitable candidate for multi-antenna microwave medical diagnosis systems.

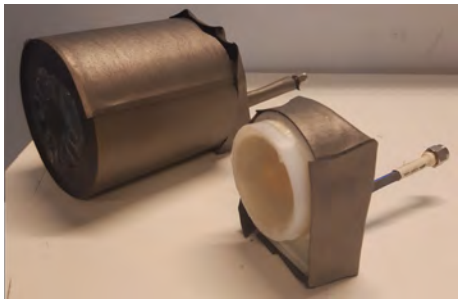

Figure 1. Dielectric Rod Antenna (left) and Self Grounded Bow-Tie Antenna (right)

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