Determining the Relative Permittivity of Deep Embedded Biological Tissues

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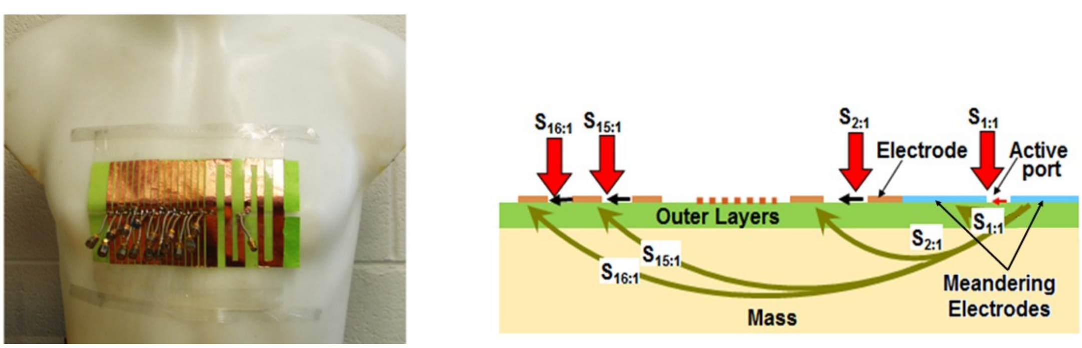
Human tissue characterization, deep into the body, has been of interest for decades. X-rays are used for locating tumors. However, such surgery-free identification methods fail to verify whether tumors are benign or malignant without surgical extraction and testing of sample tissue. Moreover, X-ray scans do not allow for continuous time monitoring because frequent exposure to ionizing radiation and contrast agents is harmful to the human body. Probe methods do provide accurate approximation of the dielectric constant ε_r but requires direct access to the specimen, making them suitable only for in-vitro applications. On the other hand, while common wearable health monitoring systems are advantageous for everyday use, they are mainly focused on simple functions such as temperature, and heart rate monitoring.

To address this shortcoming, herewith we propose a novel wearable, surgery free, health monitoring system composed mainly of a flexible multi-probe sensor (Fig. 1) to enable internal organ monitoring at least 10 cm deep without using *in-vivo*/implanted detectors. This surgery-free method is an on-body monitoring system to evaluate the electrical properties of internal organs (lung, heart, etc.) and effectively detect irregularities in real-time. The method uses a set of electrodes at a single low frequency to obtain data that relates to the electrical properties of the underlying biological tissue. By using multiple electrodes, the effects of outer layers (skin, fat and muscle) are suppressed allowing for the characterization of deeper layers. Through the unique dielectric properties of biological tissues we are able to identify and differentiate organs and tissues from each other. Simulated results showed that it is possible to identify dielectric values of biological tissue deep into the torso. Parametric and measurement studies will be presented to validate the concept. In this effort, the planar sensor developed can detect ε_r changes with less than 7% variability. Such distinction facilitates low cost unobtrusive solutions for continuous health monitoring and is expected to enable early detection and better treatment.



(a) (b)

Fig. 1, (a) Electrode set placement on torso and (b) phantom cross section view of the fringing field behavior through the layers.