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A data analysis application for a systematic reporting of dielectric properties of biological tissue.

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The dielectric properties of biological tissues are the basis of new and existing medical devices which utilise microwaves. To date, numerous studies have been published which report on the dielectric properties for various biological tissues. When examining published literature, it is apparent that discrepancies in the methodology exist along with the way the data is analysed and reported. In this work, we present a data analysis application developed in Matlab which allows the user to import multiple dielectric data files and analyse them simultaneously. The analysis is developed as per a best-practices guidelines developed as consensus work within the COST MyWAVE network. The application allows for data importing and identification of experimental outliers. The latter applies for measurements of the complex permittivity of biological tissues conducted as a function of frequency and is based on the Kramer's Kronig (KK) relations [1]. Generally, when measuring the complex permittivity of biological tissue at microwave frequencies, measurements are conducted as a function of frequency and then modelled mathematically using a Cole-Cole equation together with a conductivity term [2]. This equation satisfies KK relations, given that the dielectric response of the MUT is both linear and causal. Therefore, knowing the dispersion law a priori, a pre-defined threshold on the residuals could be used as an identifier of experimental outliers.

The program also allows for the determination of the Debye and/or Cole-Cole parameters for filtered experimental data. Additionally, a tab which allows for the uncertainty in the measured data is included. The method for uncertainty calculation is based on the method reported by Peyman et al [3].

The application will be made available for download, as an open source, on the COST MyWAVE website. This is inline with the MyWAVE dielectric data repository also available on the COST MyWAVE website.

References

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[2] Gabriel, S., Lau, R. W., & Gabriel, C. (1996). The dielectric properties of biological tissues: III. Parametric models for the dielectric spectrum of tissues. Physics in medicine & biology, 41(11), 2271.
[3] Gabriel, C. and Peyman, A., 2006. Dielectric measurement: error analysis and assessment of uncertainty. Physics in Medicine & Biology, 51(23), p.6033.

[1] Both conditions are generally satisfied since the amplitude of the applied electric-field is low and ε' increases when σ decreases.