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An Inverse Heat Transfer Algorithm for Predicting the Thermal Properties of Tumors during Cryosurgery

Authors : Mohamed Hafid, Marcel Lacroix

Abstract : This study aimed at developing an inverse heat transfer approach for predicting the time-varying freezing front and the temperature distribution of tumors during cryosurgery. Using a temperature probe pressed against the layer of tumor, the inverse approach is able to predict simultaneously the metabolic heat generation and the blood perfusion rate of the tumor. Once these parameters are predicted, the temperature-field and time-varying freezing fronts are determined with the direct model. The direct model rests on one-dimensional Pennes bioheat equation. The phase change problem is handled with the enthalpy method. The Levenberg-Marquardt Method (LMM) combined to the Broyden Method (BM) is used to solve the inverse model. The effect (a) of the thermal properties of the diseased tissues; (b) of the initial guesses for the unknown thermal properties; (c) of the data capture frequency; and (d) of the noise on the recorded temperatures is examined. It is shown that the proposed inverse approach remains accurate for all the cases investigated.

Keywords : cryosurgery, inverse heat transfer, Levenberg-Marquardt method, thermal properties, Pennes model, enthalpy method
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