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Numerical Modelling of Skin Tumor Diagnostics through Dynamic Thermography

Authors : Luiz Carlos Wrobel, Matjaz Hribersek, Jure Marn, Jurij Iljaz

Abstract : Dynamic thermography has been clinically proven to be a valuable diagnostic technique for skin tumor detection as well as for other medical applications such as breast cancer diagnostics, diagnostics of vascular diseases, fever screening, dermatological and other applications. Thermography for medical screening can be done in two different ways, observing the temperature response under steady-state conditions (passive or static thermography), and by inducing thermal stresses by cooling or heating the observed tissue and measuring the thermal response during the recovery phase (active or dynamic thermography). The numerical modelling of heat transfer phenomena in biological tissue during dynamic thermography can aid the technique by improving process parameters or by estimating unknown tissue parameters based on measured data. This paper presents a nonlinear numerical model of multilayer skin tissue containing a skin tumor, together with the thermoregulation response of the tissue during the cooling-rewarming processes of dynamic thermography. The model is based on the Pennes bioheat equation and solved numerically by using a subdomain boundary element method which treats the problem as axisymmetric. The paper includes computational tests and numerical results for Clark II and Clark IV tumors, comparing the models using constant and temperature-dependent thermophysical properties, which showed noticeable differences and highlighted the importance of using a local thermoregulation model.

Keywords : boundary element method, dynamic thermography, static thermography, skin tumor diagnostic
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