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MODELING STATIC THERMOGRAPHY OF CANCER BREAST BY USING NONDIMENSIONAL STEADY-STATE PENNES EQUATION

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Breast cancer is the most commonly diagnosed type of cancer in the world and cure rate depend on stage of diagnosis. In cancer detection in early stages, infrared thermography plays an important role. It is known that temperature deviations from normal state in the human body often use as an indicator of illness and progression of a disease. For example, a typical thermogram of tumor breast reveals temperature elevation at the periphery of the tumor [1, 2]. Breasts infrared image of woman, who has the tumor, is shown in figure 1.

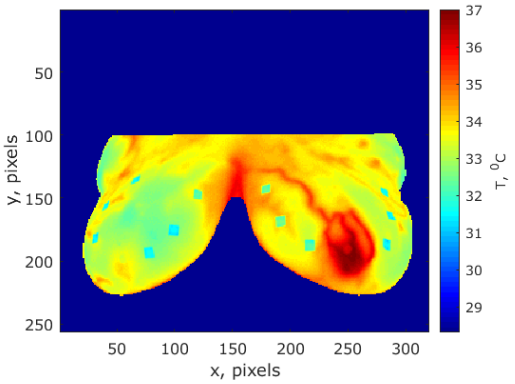

Fig. 1. Breasts infrared image of woman, who is 63 and has cancer

In this work we design a mathematical model of tumor breast infrared thermography in order to describe a temperature distribution on breast surface. Purpose of this work is finding qualitative difference between cancerous and normal tissues of breast.

In order to get the temperature distribution the bioheat Pennes equation and boundary conditions are used [3]:

$$-\nabla\cdot(k\nabla T) = w_b c_b(T_a - T) + q_m\,, \qquad (1).$$

$$T|_0 = T_a\,, \qquad (2).$$

$$-k\nabla T|_r = h(T|_r - T_\infty)\,, \qquad (3).$$

where k is thermal conductivity of tissue, T is tissue temperature, q_m is metabolic heat generation rate, w_b is blood perfusion rate, c_b is blood heat capacity, T_a is arterial blood temperature, h is heat transfer coefficient between breast surface and air, T_∞ denotes ambient temperature [3].

The steady-state Pennes equation (1) and boundary conditions (2), (3) are led to the dimensionless form to follow the Frank-Kamenetsky representation in the burning theory [4]. Two dimensionless parameters for equation (1) and one parameter for boundary condition (3) were introduced in order to analyse qualitative differences between cancerous and normal tissue. For example, dimensionless parameter $\beta = (w_b c_b r^2)/k$, where r denotes a size of breast, has higher value for cancer tissue.

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1. Gonzalez F.J. Thermal Simulation of Breast Tumors. // Revista Mexicana de Fisica, 2007. V 53. No 4. P. 323–326.
2. Saniei E et al., Parameter estimation of breast tumour using dynamic neural network from thermal pattern. // Journal of Advanced Research, 2016
3. Jiang L. et al. Modeling static and dynamic thermography of the human breast under elastic deformation // Physics in Medicine and Biology, 2011. V. 56. P. 187–202.
4. Frank-Kameneckiy D.A. Diffuzija i teploperedacha v himicheskoj kinetike [Diffusion and heat transfer at chemical kinetics]. Moscow. Nauka. 1987. 502 p.