Chapter 12
Applications of the Use of Infrared Breast Images: Numerical Calculations of Temperature Profile and Estimates of Thermophysical Properties

Luciete Alves Bezerra
https://orcid.org/0000-0002-5363-7545
Federal University of Pernambuco, Brazil

João Roberto Ferreira de Melo
Federal University of Pernambuco, Brazil

Paulo Roberto Maciel Lyra
DEMEC, Federal University of Pernambuco, Brazil

Rita de Cássia Fernandes de Lima
DEMEC, Federal University of Pernambuco, Brazil

ABSTRACT

In this chapter, procedures for and applications of using infrared (IR) imaging that have been developed will be presented and proposed means by which a better detailed understanding of breast cancer can be reached. It will be shown how such applications can be used as a basis for enhancing the use of breast thermographic imaging as a user-friendly and inexpensive tool for the early detection of breast cancer. The authors intend to show that IR imaging can also be used to validate temperature profiles that have been calculated and to classify breast abnormalities as set out in previous chapters. IR images can also be used to estimate thermophysical properties of the breast, and discussion of how this is done is included. The IR images were acquired at the Outpatients Clinic of Mastology of the Hospital das Clínicas of the Federal University of Pernambuco (HC/UFPE). The research project was registered in the Brazilian Health Ministry (CEP/CCS/UFPE nº 279/05) after being approved by the Ethics Committee of UFPE.

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INTRODUCTION

In this chapter, procedures for and applications of using infrared (IR) imaging that have been developed will be presented and proposed means by which a better detailed understanding of breast cancer can be reached. It will be shown how such applications can be used as a basis for enhancing the use of breast thermographic imaging as a user-friendly and inexpensive tool for the early detection of breast cancer. We intend also to show that IR imaging can also be used to validate temperature profiles that have been calculated and to classify breast abnormalities, as set out in previous chapters.

IR images can also be used to estimate thermophysical properties of the breast and discussion of how this is done is included.

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More and more early women are being diagnosed with some alteration in the breast. Mammography, despite being a highly sensitive test, does not provide reliable results when the breast tissue is very dense, with a predominance of glandular tissue. Therefore, its sensitivity is directly related to the patient's age. For this reason, and because mammography uses ionizing radiation, mammography is therefore considered a risk factor for breast cancer (El-Bastawissi, White, Mandelson, & Taplin, 2001, 2010). Therefore, mammography is not indicated for very young women, it being recommended only for women over 40 years old (Udesc, 2007). On the other hand, thermography can play an important role in early diagnosis for young patients with dense breasts (Schaefer, Z ´Avisek, & Nakashima, 2009; Acharya, Ng, Tan, & Sree (2012); Lahiri, Bagavathiappan, Jayakumar, & Philip, 2012; EtehadTavakol, Chandran, Ng, & Kafieh, 2013). According to these authors, the technique in conjunction with clinical examination shows sensitivity for detecting breast cancer, close to that of mammography, for women under 40 years of age.

IR images can also be used to validate three-dimensional, numerical simulations. The aim of such simulations is to achieve a better understanding of breast abnormalities. According to Ng and Sudarshan (2001) and Ng and Sudarshan (2004), numerical simulations in conjunction with thermography can be used as an auxiliary tool for mammography in the detection of breast cancer, in addition to which these simulations reduce the false positives of thermography in the diagnosis of cancer. To build a more realistic model for the breast, reliable values of thermophysical properties are needed for the various types of breast tissues and the various disorders of the breast. Finding values for such properties is therefore the biggest limitation of precise numerical simulation in living tissues. To overcome this difficulty, it is proposed to use thermographic images in conjunction with an inverse method coupled to a numerical simulator to make a first estimate of the real thermophysical properties of the breast and of nodules of the breast, using a simplified breast model, which initially was considered to consist of a homogeneous medium.

Several authors such as: Mitra and Balaji (1992), Paruch and Majchrzak (2007), Mital (2008), Jiang, Zhan, and Loew (2011), Agnelli, Barrea, and Turner (2011) estimated the thermophysical properties of tumors using temperatures obtained from numerical simulations with an additional random error. In this chapter, temperatures obtained from the IR images of each patient will be used, thus improving understanding, and the estimate of thermophysical properties will then be customized for each patient analyzed. These images have great potential as an auxiliary tool in detecting breast cancer.