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Diagnosis of Soft Tissue Cancers Using Thermography Technique Based on Artificial Tactile Sensing Approach

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Abstract
In this study, capability of a new developing method in soft tissue cancer detection is investigated which is called "thermography". Thermography is a noninvasive technique which measures the temperature distribution of soft tissue. A numerical model of soft tissue including a cancerous tumor is proposed. Temperature variation on the tissue surface is obtained and symptom of tumor existence will be explored. Effects of two major tumor geometrical parameters which are depth and diameter are inspected. Moreover than the geometrical parameters of the tumor, the tissue itself plays an important role in tumor detection. Three different types of soft tissues including breast, brain and kidney with different thermal properties containing a predefined tumor inside the tissues are studied. Results include maximum temperature measured on the surface of the tissue, area on the surface containing sensible temperature gradient relative to the normal tissue and heat flux transferred to the arterial blood. It will be deduced that thermography has an acceptable performance in tumor detection over a wide range of soft tissue cancers.

Keywords: Thermography, Tumor, Soft Tissue, Finite Element Analysis, Noninvasive

Introduction

Breast cancer is the most common cancer among women, except for non-melanoma skin cancers [1].

More than 1.2 million people are diagnosed with breast cancer each year worldwide and over 500,000 die from this disease [2].

Nowadays there are many common and developing methods for breast cancer detection. Each of these methods has its own limitations and disadvantages. One of the major shortcomings of the available methods is their disability in the detection of deeply located tumors [3, 4].

Temperature changes within the human body in relation to disease have been recognized for many centuries. In particular, elevated body temperature has been used as an index of illness and often as an indicator of the progression of a disease [5]. Infrared imaging was introduced into medicine in the late 1950s. Early studies suggested there were applications of the technology in areas as diverse as detection of breast cancer and malfunctions of the nervous system. However, the early instrumentation was not sensitive enough to detect the subtle changes in temperature needed to accurately detect and monitor disease [5-7]. In recent years, the sensitivity of infrared instruments has greatly improved so that it now approaches 0.025 °C, a level at which 0.05 to 0.1 °C differences or changes in temperature can now be reliably measured. The development of focal plane technology has permitted very high-quality imaging as well as the export of digital temperature measurements to computer-assisted image analysis and algorithm development [5, 7].

Thermography is a new developing non-invasive method with no harmful effects of x-ray accumulation in the body or biopsies invasiveness. It also can be used for people of all ages. It is also used without restriction for women during pregnancy [8].

In this study, capability of thermography technique in soft tissue cancer detection was investigated. We proposed a numerical model of soft tissue including a cancerous tumor. It is quite well known that the tumor has a higher temperature relative to the normal surrounding tissue. So, temperature variation on the tissue surface was analyzed and symptom of tumor existence was explored. For the sake of completeness, effects of two major tumor geometrical parameters which are depth and diameter were also inspected. Moreover than the geometrical parameters of the tumor, the tissue itself plays an important role in tumor detection. Three different types of soft tissues including breast, brain and kidney with different thermal properties were modeled while a predefined tumor was embedded inside the tissues. Results include maximum temperature measured on the surface of the tissue, area on the surface containing sensible temperature gradient relative to the normal tissue and heat flux transferred to the arterial blood.

Definition of the problem

In many diagnostic tests, physicians examine the patient's body using the fingers and palm to obtain information on conditions inside the body. Such a diagnostic test can be used to detect tumors [9]. The present study investigated the thermal effects of an embedded object as a tumor on the surface of tissues. Having considered temperature variations of the tumor and modeled it using a computer, thermal changes appearing on the surface and depth of the tissue as a result of the embedded object were studied.

Modeling, simplifications and assumptions