# Chapter 7
# The Evolution of New Trends in Breast Thermography

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## ABSTRACT

*In this chapter, the theoretical foundations of infrared radiation theory and the principles of the infrared imaging technique are presented. The use of infrared (IR) images has increased recently, especially due to the refinement and portability of thermographic cameras. As a result, this type of camera can be used for various medical applications. In this context, the use of IR images is proposed as an auxiliary tool for detecting disease and monitoring, especially for the early detection of breast cancer.*

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## INTRODUCTION

In this chapter, the theoretical foundations of Infrared Radiation Theory and the principles of the infrared imaging technique are presented.

The use of infrared (IR) images has increased recently, especially due to the refinement and portability of thermographic cameras. As a result, this type of camera can be used for various medical applications.

In this context, the use of IR images is proposed as an auxiliary tool for detecting disease and monitoring, especially for the early detection of breast cancer.

### Thermal Radiation: Some Theoretical Considerations

"Thermal radiation (radiative heat transfer) is the science of transferring energy in the form of electromagnetic waves". It does not require a medium for propagation and is the dominant mode in outer-space applications or in a vacuum (Modest, 2013).

According to Incropera and DeWitt (1996), radiation begins by being emitted from a body. But this radiation does not require the presence of any material for it to be transported. There is a theory that considers that radiation is the propagation of particles termed photons or quanta. Another theory considers that radiation is the propagation of electromagnetic waves that travel at the speed of light.

Planck stated that electromagnetic radiation, including thermal radiation, is emitted as discrete quanta of energy E,

$$E = h\nu \tag{1}$$

where $h = 6.625 \times 10^{-34}$ J.s is Planck's constant and $\nu$ is the frequency of the radiation.

A few years later, Einstein proved that electromagnetic radiation behaves like a collection of quanta with energy equal to h $\nu$. In 1905, he used the concept of the quantum nature of light to explain some particular properties of metals (Gasiorowicz, 1979).

All electromagnetic radiation obeys similar laws of reflection, refraction, diffraction and polarization. This radiation propagates at the speed of light.

As bodies emit or absorb electromagnetic waves, their internal energy changes, at a molecular level. The process depends on the temperature and the wavelength.

The spectrum of thermal radiation ranges from 0.1 $\mu m$ to 100 $\mu m$ and includes almost all the infrared part of the spectrum, the visible light and a small part of the ultraviolet spectrum. The infrared portion of the electromagnetic spectrum begins at a wavelength of 0.7 and extends to 1000 $\mu m$ (Figure 1).

In the early 1900s, thermal radiation included the part mentioned above because the known engineering applications at that time occurred at that interval. Nowadays, it is considered that all bodies above 0K emit thermal radiation. This radiation can be used to obtain IR images of an object by using IR detectors.

In our considerations here, radiation is a surface phenomenon because, in most solids and liquids, the radiation emitted from interior molecules is absorbed by the adjacent molecules. However, the radiation emitted from a body originates from molecules located at 1 $\mu m$ below the outer surface (Modest, 2013).

According to Incropera and DeWitt (1996), a blackbody has the following properties: