Chapter VIII
Automated Overlay of Infrared and Visual Medical Images

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ABSTRACT

Medical infrared imaging captures the temperature distribution of the human skin and is employed in various medical applications. Often it is useful to cross-reference the resulting thermograms with visual images of the patient, either to see which part of the anatomy is affected by a certain disease or to judge the efficacy of the treatment. In this chapter, we show that image registration techniques can be effectively used to generate an overlay of visual and thermal images and provide a useful diagnostic visualisation for the clinician.

INTRODUCTION

Medical infrared imaging captures the natural thermal radiation generated by an object at a temperature above absolute zero. It is non-invasive, non-contact, passive, radiation-free and complementary to anatomical investigations based on x-rays and three-dimensional scanning techniques such as CT and MRI, and often reveals problems when the anatomy is otherwise normal. Often, visual and infrared images of the patient are taken to relate inflamed skin areas to the human anatomy which in turn is useful for medial diagnosis as well as for assessing the efficacy of any treatment. Currently, this process requires great expertise and is subject to the individual clinician's ability to mentally map the two distinctly different images.

Image registration is one of the most important medical image processing techniques and is used to geometrically align or overlay two images taken from different sensors, viewpoints or instances in time. Both images are typically aligned through a combination of scaling, translation and rotation. Registration is often used to monitor growth, verify the effects of treatment and make comparisons of patient data with anatomically normal subjects.

In this chapter, we show how image registration can be effectively used to overlay medical infrared images and visual images of a patient in order to relate areas that are of interest due to their thermal pattern to the human anatomy. After capturing both thermal and visual images, the visual image is pre-processed with a skin detection technique to separate the patient from the background. Using an intensity-based registration algorithm which requires no user interaction, visual and infrared images are then superimposed and the generated overlay presented to the user for visualisation purpose. The generated system is currently in use at Royal Free and Great Ormond Street hospitals to assess patients suffering from morphea.

BACKGROUND

Thermal Infrared Imaging

Advances in camera technologies and reduced equipment costs are among the factors that have led to an increased interest in the application of thermal imaging in the medical fields (Jones, 1998). Thermal medical imaging (or medical infrared imaging) uses cameras with sensitivities in the infrared to provide a picture of the temperature distribution of the human body or parts thereof. It is a non-invasive, non-contact, passive, radiation-free technique that is often being used in combination with anatomical investigations based on x-rays and three-dimensional scanning techniques such as CT and MRI and often reveals problems when the anatomy is otherwise normal. It is well known that the radiance from human skin is an exponential function of the surface temperature which in turn is influenced by the level of blood perfusion in the skin. Thermal imaging is hence well suited to pick up changes in blood perfusion which might occur due to inflammation, angiogenesis or other causes. Asymmetrical temperature distributions as well as the presence of hot and cold spots are known to be strong indicators of an underlying dysfunction (Uematsu, 1985). Computerized image processing and pattern recognition techniques have been used in acquiring and evaluating medical thermal images (Plassmann & Ring, 1997; Wiecek, Zwolenik, Jung, & Zuber, 1999) and proved to be important tools for clinical diagnostics. Thermal imaging has been successfully employed in, among others, detecting breast cancer (Head, Wang, Lipari, & Elliott, 2000; Anbar et al., 2001), diagnosing Raynaud's phenomenon (Merla et al., 2002), and local scleroderma (morphea) (Black et al., 2002).

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