

Analyzing the Locus of Patients Movement for Registration of Thermal Images in Breast Examination

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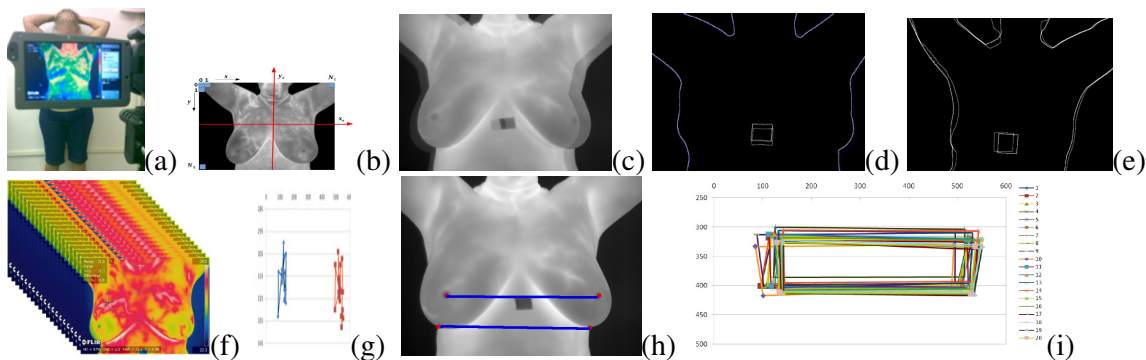
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A thermal camera that captures heat patterns radiated by the skin surface can serve as an important indicator in medical diagnostics. Thanks to the advances in infrared (IR) thermal imaging technology, image processing techniques and the understanding of thermograms, IR is very suitable for use as a supplement to health monitoring and clinical diagnosis. Analyzing and interpreting thermograms has been increasingly employed in the diagnosis and monitoring of breast diseases thanks to its non-invasive, non-harmful nature and low cost [1]. It is called *mammothermography*, and has been very effective in the early detection of breast cancer. These techniques are especially efficient when dynamic protocol (a series of images acquired in a fixed time interval with induced changes in the breasts temperature) is assisted by computational methods [2,4]. However, for such an examination the patient must be standing up with her hands behind her head for 5 minutes (see image a). If in this interval the patient makes small movements that change the position of her body in relation to the scene coordinates (image b), these differences can result in error in the computational analysis. Therefore, the approaches for correcting the errors relative to these points are the first and decisive step in computational analysis of these thermograms, and this alignment must be properly done before doing the computational analyses [5]. Alignment among images that is taken at different times, positions or angles, is known as image registration [3]. Image registration matches points of the scene using various types of transformations, from rigid bodies (translation and rotation), to non-rigid and even to Möbius transformations [6], i.e., linear fractional transformations. However, image registration is a context -driven problem, and the use of more generic or incorrect mathematical functions increases the processing time, and does not guarantee adequate results. To achieve the purpose of a proper development of a registration tool for help in the interactive, real time visualization and diagnostic system for breast examination, we need first to know the problem (the differences between images and how they are caused). In this work, we observe that in a dynamic acquisition, the differences between images are due to the respiration, and even to small changes in the equilibrium of the patient. Image f shows the position of the breast nipples in a sequence of 20 frames in one of these examinations. We use a sequence of frames available in a public database in order to analyze the possible geometry of such movements [4]. We consider 4 points of the body of the patient (image h and i) and three types of displacements are then identified: a lateral movement in the coronal plane (image c); a forward-backward displacement (image d); and a torsion deformation along her cranium-caudal axis (image e). From this we can define the type of functions that can be used in correcting the errors in a registration process described above. It was found that Möbius transformations (linear-fractional transformations, which include linear mappings), among the series of images of the same examination, are the best kind of function to be used in this registration mapping. The method developed for finding this function was tested in a heterogeneous group of 23 patients; the results show better improvement in the average alignment for all patients [7].



The patient position on the examination (a), coordinates of the acquired frames and the patient's body (b), 2 frames overlap to enhance the lateral displacement (c); overlap of the edge detected in order to show the movement toward and away from the camera (d); and the body torsion displacement (e). A sequence of frames to be registered (f). Example of definition of the areolas displacements during the examination (g). Some characteristic points in the body (h) and the coordinates of these points in each frame.

Key-words:

Dynamic Infrared Image, Image Registration; Thermograms, Rigid Body Motion, Affine Transformation, Möbius Transformation.

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