

## Abstract

Medical image registration is an important research area in medical image analysis. The medical image registration algorithms are used, among others, in applications dedicated to tumor growth monitoring, the creation of the anatomical atlases, compensating the patient movement during the breathing process, or the correction of intraoperative movements. Image registration is a process of aligning two or more images to the same coordinate system by calculating a correct transformation. The transformed image is named the source image, while the template image is called the target image. An essential aspect of medical image registration is the problem of missing data. It occurs when a given structure, present in one of the images, is absent or invisible in the second image. The problem is significant for supportive radiotherapy planning, the registration of histology images acquired using different stains, or the intra-operative movement correction during surgery.

The hypothesis made in this dissertation is that algorithms dedicated to the missing data problem may improve the quality of the geometric transformations calculated during the medical image registration.

In the first part of the dissertation, the author introduces the current state-of-the-art in medical image registration. It begins with a general introduction to image registration. Then, the state-of-the-art of deep learning in medical image registration is presented. Finally, the author discusses the sources of missing data and presents the difficulties resulting from the missing structures.

In the second part of the dissertation, the author presents his own research and contributions. The thesis's main contributions are specialized algorithms dedicated to missing data in medical image registration. The thesis author introduces both classical, iterative algorithms as well as novel, deep learning-based methods. The proposed algorithms address the following problems: (i) the registration of histology images acquired with different

dyes, (ii) the localization of tumor bed after the breast-conserving surgery, and (iii) the intra-operative movement correction in ultrasonography images acquired during glioma surgery.

Finally, the author summarizes the dissertation, specifies further research directions, and briefly presents his current research record and achievements.

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