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NUMERICAL SOLUTION FOR DEFORMABLE IMAGE REGISTRATION USING RADIAL BASIS FUNCTIONS

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Abstract. The radiotherapy treatment plan for cancer cases is usually designed according to the information from computed tomography scans. However, geometric change of the target region and side effect on healthy organ over the process of radiation therapy may lead to severe treatment uncertainties. Therefore, the radiotherapy dose has to be adjusted carefully to accommodate the changes of the target region. In medical application, the deformation image registration (DIR) is an important process to find out the transformation mapping between the two images. Once the transformation is found, it is applied to the target region. The result is therefore the new target region to which the radiotherapy dose is applied. Minor adjustment of the new radiotherapy dose by experts may still be needed but the whole process can be simplified greatly.

The governing equations of the classical DIR model of the form $\mathbf{D}(|\nabla \mathbf{s}|^2 + \mathbf{F}^2) - \mathbf{F}\nabla \mathbf{s} = \mathbf{0}$ describes the displacements $\mathbf{D}$ from the deformed image to the static image. When the forces are applied to the concerned target object, the object will be deformed due to the distorting influence. The well-known Demons algorithm can configure a transformation mapping between the profiles of tumor location based on a local iterative scheme. This paper introduces a technique which uses the Demon's algorithm as the reference, but focuses on the application of meshless radial basis interpolation functions. The proposed meshless scheme will be incorporated with the Demon's algorithm to compute the transformation of deformation images. The major features of the proposed method will be identified and the computational performances are compared with the existing DIR algorithms.

Keywords. Deformable image, Radial basis functions, Demon's algorithm.

AMS (MOS) subject classification: 65N35, 65D05

1 Introduction

The external radiotherapy is a common medical treatment during cancer diseases treatment. In order to inhibit the tumor growth and minimize the side effects to the patient, confining the treatment to a well-defined target region