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EFFICIENT 3D REGISTRATION USING TWO-STAGE SCHEME AND SPATIAL FILTER

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Abstract. *This paper proposes a fast and robust three-dimensional human face registration strategy dedicated for image-guided medical applications. In order to reduce data amount effectively while preserving data points that adequately describe curvatures, a spatial filter and a truncation procedure are introduced. The proposed registration scheme is composed of a coarse registration stage and a fine-tuning stage. In the first stage, the data amount of the image is reduced by the filter and a homogeneous selection procedure, and evolutionary computation is implemented to find global optimal rigid body transformation that aligns two 3D images. In the second stage, complete data sets before the selection procedure are exploited using the iterative closest point plus k-dimensional tree scheme. To illustrate the validity of the proposed approach, two representative problems are demonstrated. Computational results of an actual registration problem show that our approach accelerates the registration process from 356.2 seconds to 19.3 seconds when compared with a genetic algorithm and iterative closest point scheme, while the average misalignment distance reduces from 1.9508 mm to 1.1024 mm.*
Keywords: Rigid-body registration, Spatial filter, Evolutionary computation, Iterative closest point, Image-guided therapy

1. **Introduction.** Registration of 3D geometric data coming from multimodal images is essential in medical imaging for exploiting the complementary information between them [1,9,10], or for image-guided procedures, such as positioning in frameless neurosurgery [2,3]. Potential applications of the proposed 3D alignment methodology include accurate positioning for medical surgery [4,5] and pose invariant face recognition [6,7]. The registration is usually defined as the procedure of aligning a model image with a reference image [1,4]. In medical applications, the model, or the template image, is usually acquired from computer tomography (CT) and the reference image, or the collected data, might be acquired during operation from laser range finder or on-site CT.

The Iterative Closest Point (ICP) algorithm [8-10], together with the k-dimensional tree (K-D tree) search method [11-13] has been a popular registration scheme, such as the alignment of human faces [6,7] and that of general images [14,15]. However, these schemes are extremely sensitive to choice of initial guess for their relative rigid-body transform. Usually, reliable solution requires multiple trials [16].

Besides, the approaches in the literature demand huge computing power when the reference image or the model image contains large data set, which is common in medical