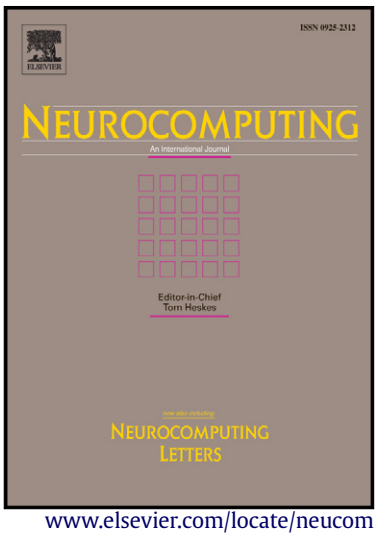

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Multi-Contour Registration Based on Feature Points Correspondence and Two-stage Gene Expression Programming

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Abstract: Image registration is a fundamental task in 3D reconstruction from an image sequence. Although this topic has been studied for decades, a general, robust, and automatic image registration method is rare, and most existing image registration methods are designed for a particular application. In this paper, image registration is treated as a formula discovery problem. A novel contour registration pipeline was proposed based on a foot-point-based feature point correspondence algorithm and a two-stage evolutionary algorithm. Our proposal has three objectives. First, we introduce a novel feature point extraction method that uses estimation of the curvature and the support region for every contour in the floating image. Second, we approximate the reference contour using a Gaussian mixture model (GMM) continuous optimization algorithm followed by an order-preserved foot-point detection method used to extract the feature points that correspond to the feature points of the floating contours. Third, we propose a hybrid evolutionary algorithm used to identify the registration formula for the reference image and the floating image. The hybrid evolutionary algorithm is a two-stage algorithm based on Gene expression programming (GEP) and the improved cooperative particle swarm optimizer (CPSO). The optimal or near-optimal structure is accomplished using the GEP algorithm, and the parameters embedded in the structure are optimized by an opposition based learning (OBL)-based cooperative particle swarm optimizer (CPSO). Compared with other non-rigid registration methods, the developed registration pipeline produces competitive results with high accuracy.

Keywords:
contour registration; foot point; GEP; feature point; CPSO; B-spline

1. Introduction

Image registration is a fundamental task in 3D reconstruction that addresses the geometric alignment of a set of images. The set may consist of two or more digital images taken of a single scene at different times, from different sensors, or from different viewpoints [1]. Many methods have been proposed to address this problem. A popular approach involves treating the salient features of the image as invariant to find the geometric transformation [2]. Using a feature-based method, a number of relevant image features are first extracted from the two images, the correspondences between the feature points are subsequently identified, and a geometric matching transformation is used to provide the best match for the two sets of features.

The most common methods of feature extraction are the contour-based hierarchical method [3] and the scale invariant feature transform [4]. The general feature correspondence algorithms include the assignment algorithm [5], the graph-matching method [6], the speeded-up robust features approach [7], and the expectation conditional maximization algorithms [8]. The transformation parameters estimation method is carried out based on the detection of features that have undergone feature correspondence. In most existing feature-based techniques, the feature correspondence is still the most challenging problem.

The feature-points-based contour matching problem can be carried out as follows [9]: First, we extract a set of feature points from each object, e.g., by running an edge detector over each image and sampling from the edges. Second, we determine the pairs of corresponding features in the two feature sets. Third, we use the correspondence information correspondence information to find an aligning transformation, such as the least squares transformation from a certain class.