Non-rigid Registration of Images with Geometric and Photometric Deformation by Using Local Affine Fourier-Moment Matching

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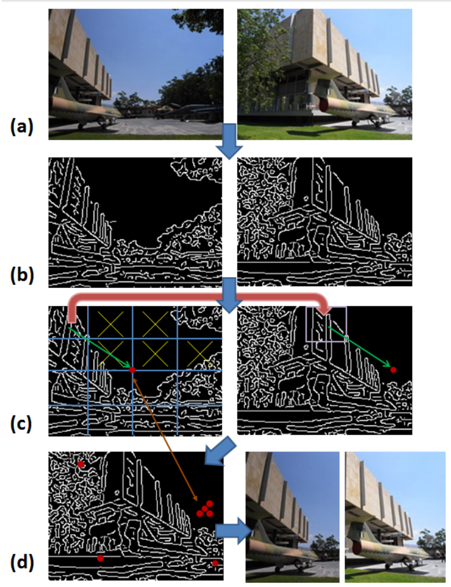

Figure 1: (a) Reference (left) and target (right) images, (b) edge maps of (a), (c) patch matching and sliding window, (d) left: target center voting in edge maps, right: image cropping with the same center.

The Fourier Moment Matching (FMM) image registration approach [1] is based on the fact that the affine transform between two images corresponds to a related affine transform between their Fourier spectrums, whose energies are normally concentrated around the origin in the frequency domain. Then, the affine transform can be solved by minimizing the affine relationship between the moments for the Fourier spectrums of the two images. FMM can be applied to 2D and 3D images easily. Hence, the photometric transform between two images can be considered as three-dimensional color histogram registration with L, a, and b color axis and the intensity from their corresponding frequency of Lab color in each image pixel. By integrating the 2D geometric image registration and 3D photometric alignment based on the Fourier moment matching, we can resolve the affine image registration problem under different illumination.

In order to make the algorithm more applicable for different viewpoint change, image distortion or image stitching, we propose a two-step hierarchal framework for weighted overlapping local affine registration based on FMM. The first step is to find the coarse corresponding area between two images by using the image block voting method on their corresponding edge maps, followed by estimating the global affine parameters in the photometric and geometric transforms by using the FMM. The second step is to find the accurate location for each pixel in images by partitioning the images into small overlapping blocks, and each block is associated with its own local affine parameters, which are determined by minimizing an energy function consisting of the FMM constraints and spatial smoothness constraints for the local affine parameters. By using a hierarchal scheme to decompose the image into blocks from a coarse scale to a fine scale, we can estimate the local affine parameters efficiently.

Furthermore, we include the FMM constraints computed from edge information into the proposed algorithm to improve the registration accuracy. We consider the photometric and geometric registration by using both the intensity and edge information. We also use a weighting function for the FMM constraint computed from each local block to increase the accuracy especially for partial matching. In addition, using local affine models in a hierarchal framework can improve registration accuracy, but it requires more computational time. We can speed up the algorithm based on the hierarchal framework. Our contributions in this paper can be summarized as follows:

1. We extend the FMM-based global affine registration to the hierarchical local affine model for non-rigid registration to deal with both the photometric and geometric registration.

2. We propose a two-step hierarchal estimation framework to estimate the local affine parameeters.

3. We combine the FMM constraints computed from the color images and edge maps in each block for estimating the local affine transformations to improve the registration accuracy.

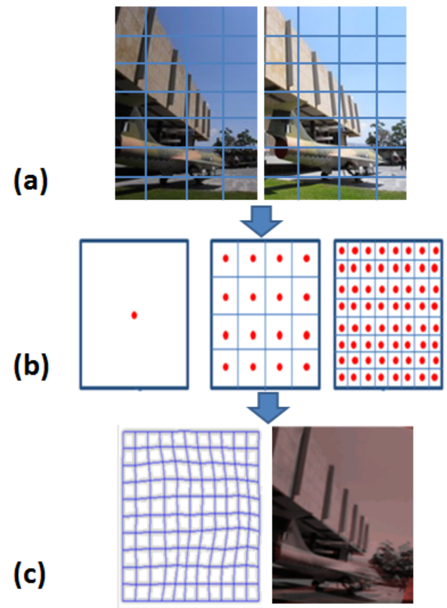

Figure 2: (a) Initial global affine estimation and image partitioning. (b) Hierarchal block partitioning for coarse-to-fine local affine estimation. (c) Image registration result.

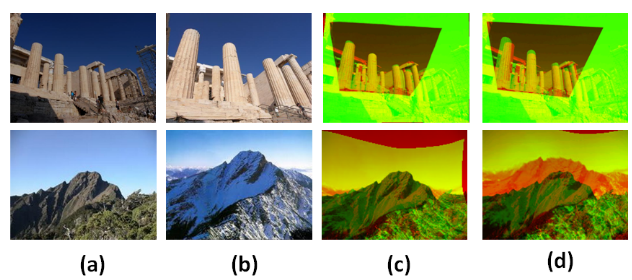

Figure 3: Some examples in our image dataset. (a) Reference images, (b) target images, registered results by the proposed algorithm (c) with and (d) without block weighting.

[1] H. R. Su and S. H. Lai. CT-MR image registration in 3D k-space based on Fourier moment matching. *In PSIVT*, 2011.

This is an extended abstract. The full paper is available at the Computer Vision Foundation webpage.