Mid-report of CV Project
Efficient MRF Deformation Model for Non-Rigid Image Matching

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1 Algorithm Pipeline

- **Input** Two images, one of which is the template image and the other is the target. The target image could be any form of the following three deformations(Figure 1).
  - Rotation + Scaling
  - Twirl
  - Twirl + Projective
- **Output** A non-rigid deformation transforming the area of interest from template image to target image
- **Crop** out the area of interest from the template image
- **Block Model** Cut the template graph into blocks with size of 4×4
- **Compute deformation** which transforms each block in template to its corresponding block in target
- **Reconstruct** the corresponding block region in target image

2 MRF energy function

The criterion of computing the corresponding block is to minimize the energy

$$E(x|\theta) = \sum_{s \in V} \theta_s(x_s) + \sum_{st \in E} \theta_{st}(x_s, x_t) \tag{1}$$

Where x_s, x_t is the labels for each block accounting for the translation. $\theta_s(x_s)$ here is the data term, which is reponsible for the similarity of some specific pixel in the template image and the corresponding pixel in the target image. $\theta_{st}(x_s, x_t)$ here is the pairwise term, which accounts for the similarity of neighbouring pixels in one image. Shown in Figure 2.

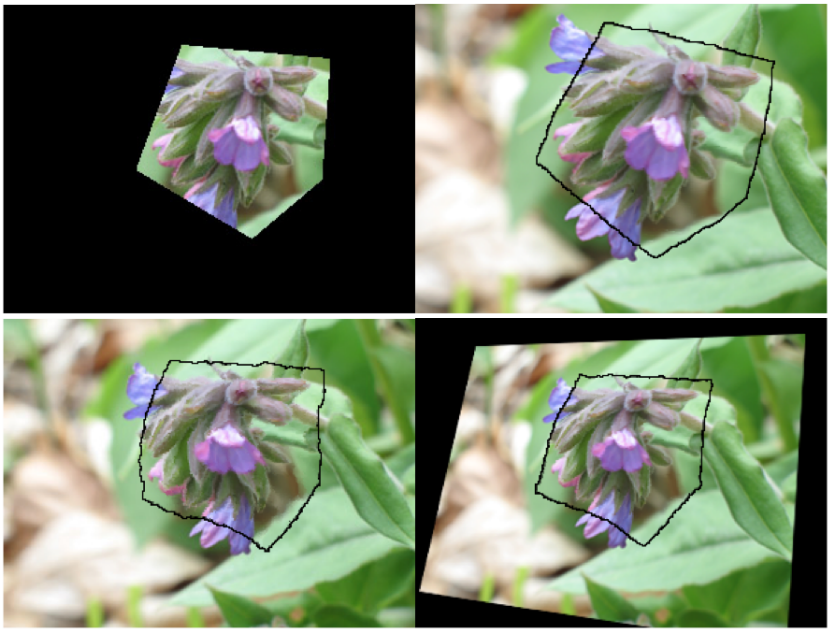

Figure 1: Three kinds of deformations

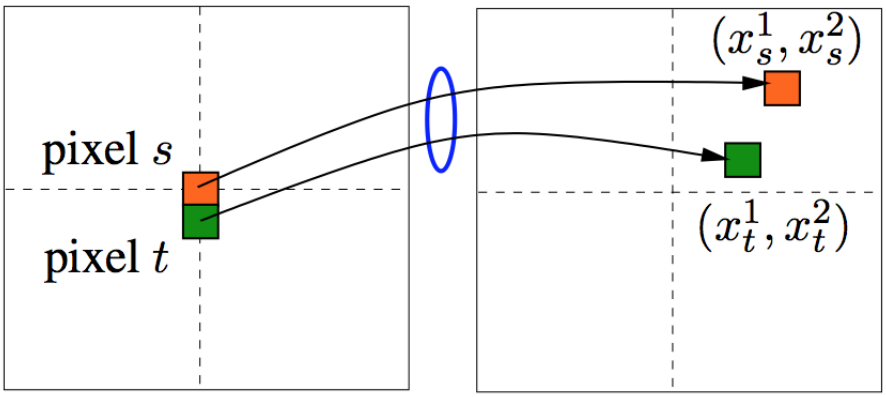

Figure 2: Data term and Pairwise term

2.1 Decomposed Model

We decompose the definition of the data term and pairwise term into two layers, one of which accounts for the translation in x direction, and the other accounting for the translation in y direction, which is shown in Figure 3. Thus, the definition of the two terms are

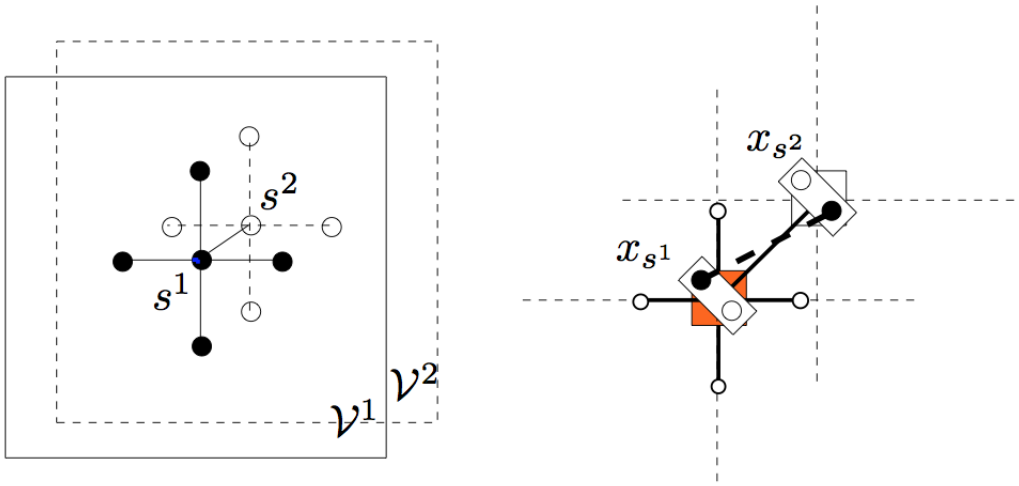

Figure 3: Two-layers Model

$$\theta_{st}(x_s, x_t) = \frac{I_s^1 - I_{s+(x_s,x_t)}^2}{2\sigma_I^2},\ s \in V^1,\ t \in V^2,\ st \in E^{12} \tag{2}$$

$$\theta_{st}(x_s, x_t) = \frac{(x_s - x_t)^2}{2\sigma_x^2},\ st \in E^i\ i = 1, 2 \tag{3}$$