Reference Paper

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0 Reference Paper

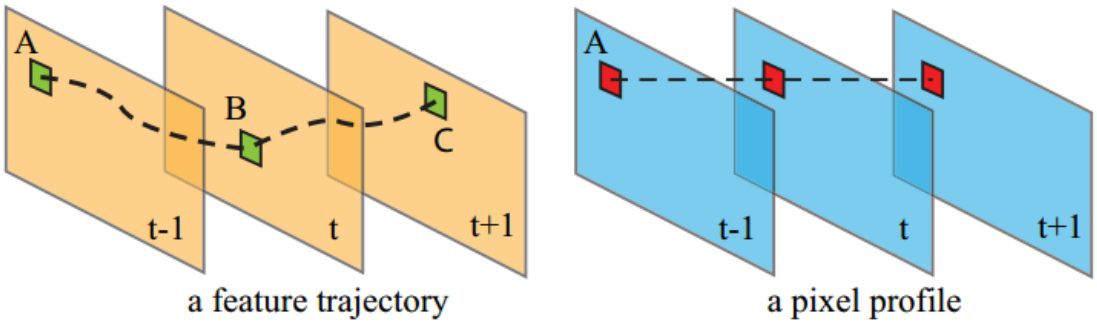
Paper Information

- S.Liu, L. Yuan, P. Tan, and J. Sun, “SteadyFlow: Spatially Smooth Optical Flow for Video Stabilization,” Int.Conf. Computer Vision and Pattern Recognition (CVPR), pp. 4209-4216, June 2014.

1 SteadyFlow Model

Pixel Profiles vs feature trajectories

- Feature trajectories: 한 point의 motion vector 모음
- Pixel Profiles: 같은 pixel 위치에서의 motion vector 모음

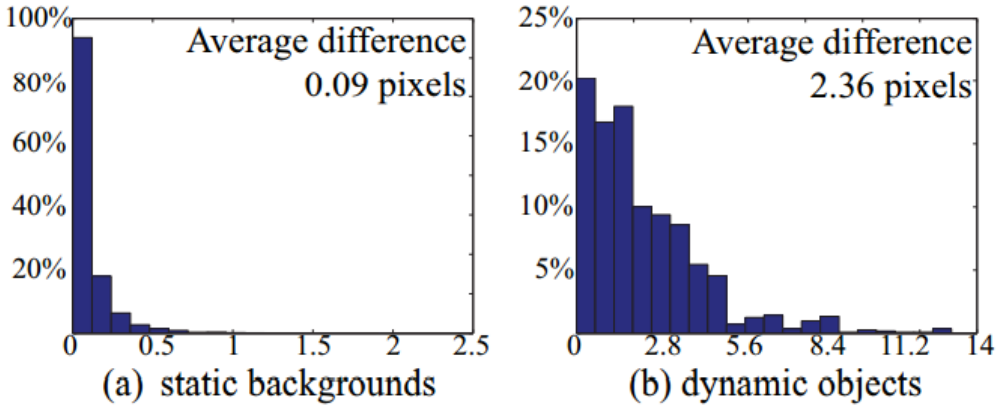


1 SteadyFlow Model

Stabilization by Smoothing Pixel Profiles

- 영상에 대해 optical flow를 구함
- Feature trajectories를 추정하기 위해 KLT tracker 사용
- Feature trajectories와 pixel profiles의 차이를 구함
  - Background : 차이가 별로 없음
  - Dynamic object : 차이가 많음

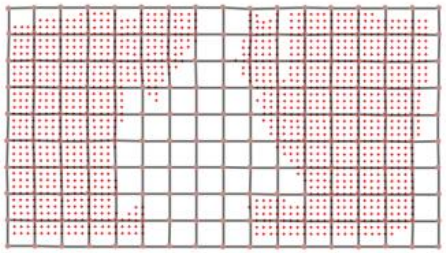
→ Pixel profiles의 smoothing을 통해 path smoothing



1 SteadyFlow Model

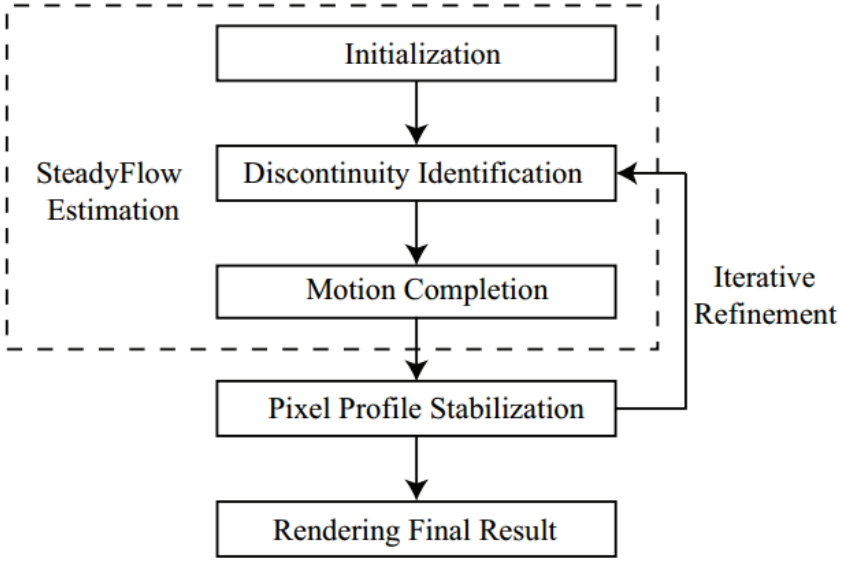
(a) original frame

(b) raw flow



(c) meshes for motion completion

(d) our SteadyFlow



2 SteadyFlow Estimation

01. Initialization

- Global homography 추정
- Optical flow 알고리즘에 적용

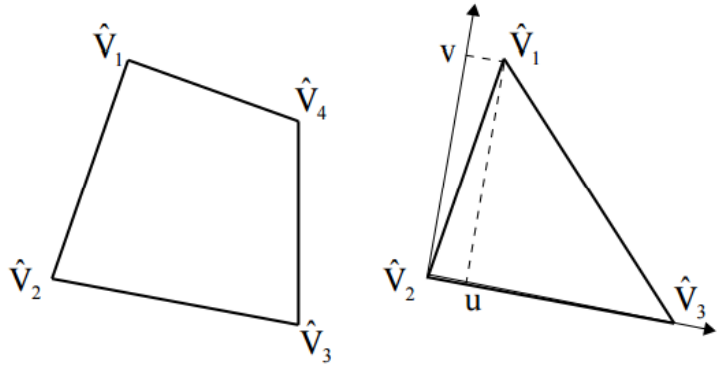
02. Discontinuity Identification

- Motion segmentation (spatial domain)
  - Outlier mask $\mathbf{M}_t(p)$
  - Optical flow의 gradient magnitude가 일정 threshold보다 크면 outlier
- Accumulate motion vector (time domain)

$$c_t(p) = \sum_t u_t(p)$$

$$\mathbf{M}_t(p) = \begin{cases} 0, & (\|c_t(p) - \mathcal{G} \otimes c_t(p)\| > \varepsilon) \\ 1, & otherwise. \end{cases}$$

2 SteadyFlow Estimation



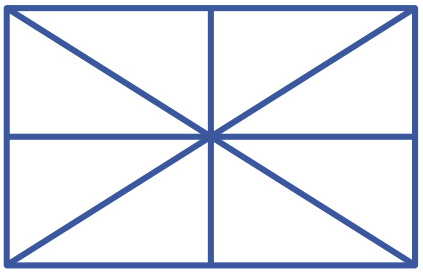
03. Motion Completion

- As-similar-as-possible warping

$$E(V) = E_d(V) + E_s(V)$$

$$E_d(V) = \sum_p \mathbf{M}(p) \cdot ||V\pi_p - (p + u_p)||$$

$$E_s(V_1) = w_s \|V_1 - (V_2 + u(V_3 - V_2) + vR_{90}(V_3 - V_2))\|^2$$



3 Pixel Profiles based Stabilization

Objective function

$$\mathcal{O}(\{\mathbf{P}_t\}) = \sum_t \left(\|\mathbf{P}_t - \mathbf{C}_t\|^2 + \lambda \sum_{r \in \Omega_t} w_{t,r} \|\mathbf{P}_t - \mathbf{P}_r\|^2 \right)$$

$$\mathbf{C}_t = \sum_t \mathbf{U}_t$$

$$\mathbf{P}_t = \sum_t \mathbf{S}_t$$

$$w_{t,r} = exp\left(-\|r - t\|2 / (\Omega_t / 3)2\right)$$

Term1: 과한 croping을 막기 위함. Original path와 어느정도는 비슷해야 함.
Term2: temporal Smoothness.

SteadyFlow 자체가 값을 계산할 때 smoothing term을 포함하였으므로, 다른 특별한 smoothing term은 필요하지 않음

0 Reference Paper

Paper Information

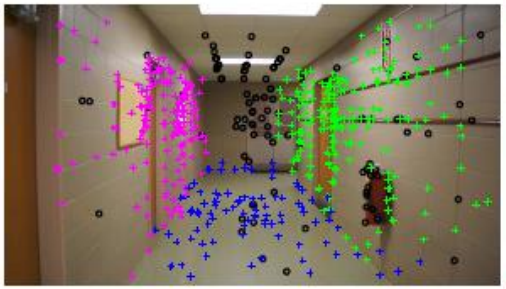
- Z. Zhou, H. Jin, and Y. Ma, “Plane-based content preserving warps for video stabilization,” Int.Conf. Computer Vision and Pattern Recognition (CVPR), pp. 2299-2306, June 2013.

1 Fast Picewise Planar and Non-Planar Scene Segmentation for Videos

01. Multiple Plane Detection

- Detect scene planes from 3D point cloud
- Structure from motion using J-Linkage
  - Generates a large number of putative models by random sampling
  - Distance from that data point is less than a threshold
    ; Jaccard distance 사용

$$d_J(A,B) = \frac{|A \bigcup B| - |A \bigcap B|}{|A \bigcup B|}$$



1 Fast Picewise Planar and Non-Planar Scene Segmentation for Videos

02. A Markov Random Field Formulation for Video segmentation

- 각 frame을 64x36의 uniform grid로 나눔
- Build graph on it
- Energy function

$$E(L) = \sum_{p_i \in \mathcal{V}} \Psi_i(l_i) + \sum_{e_{ij} \in \mathcal{E}} \Psi_{ij}(l_i, l_j)$$

$$\Psi_i(l_i) = \begin{cases} \sum_{X \in \mathcal{X}_i} \min\{\|\boldsymbol{x} - \boldsymbol{x}_k^*\|_2, d_{\max}\}, & \text{if } l_i = k > 0 \\ \beta|\mathcal{X}_i|, & \text{if } l_i = 0 \end{cases}$$

: Data term
포인트에 가장 적합한 평면을 찾게 해주는 역할

$$\Psi_{ij}(l_i, l_j) = \delta(l_i, l_j) \cdot g(i, j)$$

: Smoothness term
각 프레임 사이의 관계를 정의하여 평면을 나누는 2D intersection을 결정하는 역할

2 Plane-based Video Stabilization

Contents Preserving Warping

- Recover the original camera motion using structure from motion
- Apply Gaussian filter to generate the stabilized camera path
- 64x36 grid mesh and the content-preserving warp
  - Based on the labels a new mesh is computed

$$\boldsymbol{v}_q = \begin{cases} H_k \hat{\boldsymbol{v}}_q & \text{if } l_q = k, k = 1, \ldots, K \\ \boldsymbol{v}_q^0, & \text{if } l_q = 0 \end{cases}$$

발전방향

① Motion에 따라 plane을 나눔

② 나눠진 plane에 따라 각자 호모그래피를 구하여 warping을 수행함

③ 이 때, 나눠진 plane 간에 상관관계를 나타내주는 term 추가 필요

논문 아웃라인 작성

감사합니다.