Adherent Raindrops Detection and Removal from Long Range Trajectories

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Modeling of Blurred Raindrop

(a) Imagery model  (b) Clear raindrop  (c) Blurred raindrop

Raindrop model: (b) Appearance of a clear raindrop. (c) Appearance of blurred raindrop observed on the image plane.

Modeling in Spatio-temporal Space

(a) Spatio-temporal space  (b) Dense trajectories  (c) Nodes of a trajectory

Spatio-temporal space and dense trajectories. (a) 3D Spatio-temporal space; (b) A 2D slice visualizes the dense trajectories. (c) A trajectory consists of a number of concatenated nodes.

Video sequence  Spatio-temporal slice  Dense trajectories

(a) Clear scene  (b) Scene with a thick raindrop  (c) Scene with a thin raindrop

Video in rainy scenes and events on the trajectories. (a) A clear day scene. (b) A scene with a thick raindrop. (c) A scene with a thin raindrop. The clear scene data is from [9]; Four trajectory events are labeled as, A: Occluded by a solid non-raindrop object and drifted. B: Occluded by a thick raindrop and drifted. C: Occluded by a thin raindrop and drifted. D: Occluded by a thin raindrop but not drifted.

Detection

Data 0: synthetic raindrops – thick raindrops – surveillance camera


Data 2: synthetic raindrops – thin raindrops – surveillance camera

No

Data 3: synthetic raindrops – thin raindrops – hand held camera

No

Data 4: synthetic raindrops – thick and thin raindrops – hand held camera

No

Data 5: real raindrops – thick raindrops with glare – surveillance camera

No

Data 6: real raindrops – thin raindrops with glare – surveillance camera

No

Detection

Appearance Analysis

No event

Event A: Non-raindrop occlusion and drift

Event B: Thick raindrop occlusion and drift

Event C: Thin raindrop occlusion and drift

Event D: Thin raindrop occlusion, no drift

Appearance of trajectories

Motion Filed Completion

Data 0: thick raindrop

Comparison on motion field estimation before and after raindrop removal.

Methodology

Raindrop video \ Inter frame optical flow \ Dense trajectories \ Trajectory matching \ Raindrop removal \ Clear video

The pipeline of our method.

Raindrop features and labeling using the features. (a) Accumulated motion consistency MC (b) Accumulated appearance consistency AC (c) Accumulated sharpness SH (d) Mixture level estimation A. (e) Binary labeling of the raindrop area. (f) Multiple labeling of the mixture level.

Removal

Data 6: thick raindrop

Ground truth  Proposed  Eigen et al. (2013)  Tan et al. (2013)

Data 1: thick raindrops

Data 2: thin raindrops

Data 3: thick and thin raindrops

The raindrop removal results.

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