Selectively De-Animating Video

Jiamin Bai, Aseem Agarwala, Maneesh Agrawala, Ravi Ramamoorthi

SIGGRAPH 2012

Inspiration

http://cinemagraphs.com/

Cinemagraphs

Input Video

Final Result

De-Animating Video

Input Video

Final Result

Example Walkthrough

Input Video

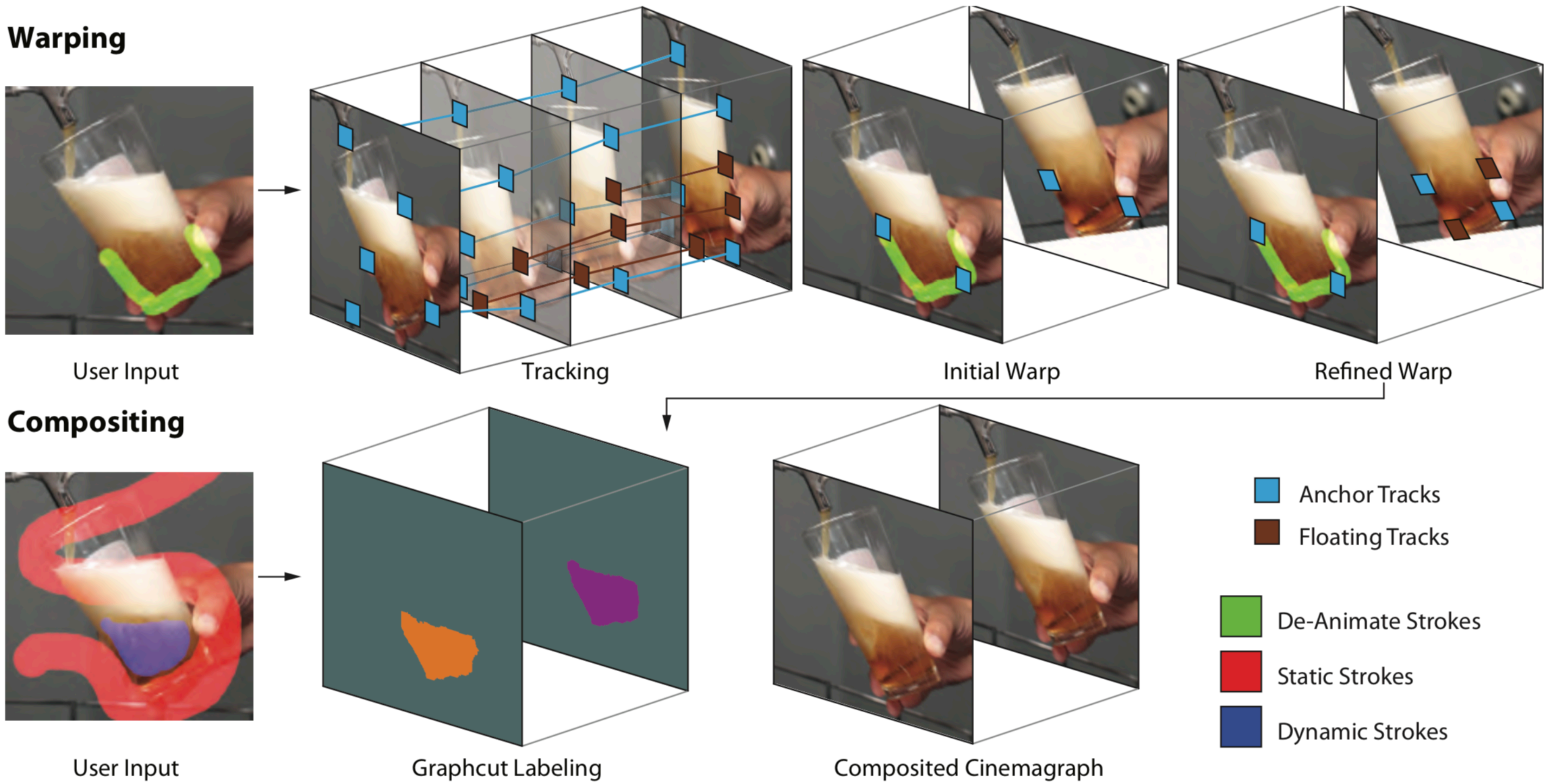
Example Walkthrough

Cinemagraphs

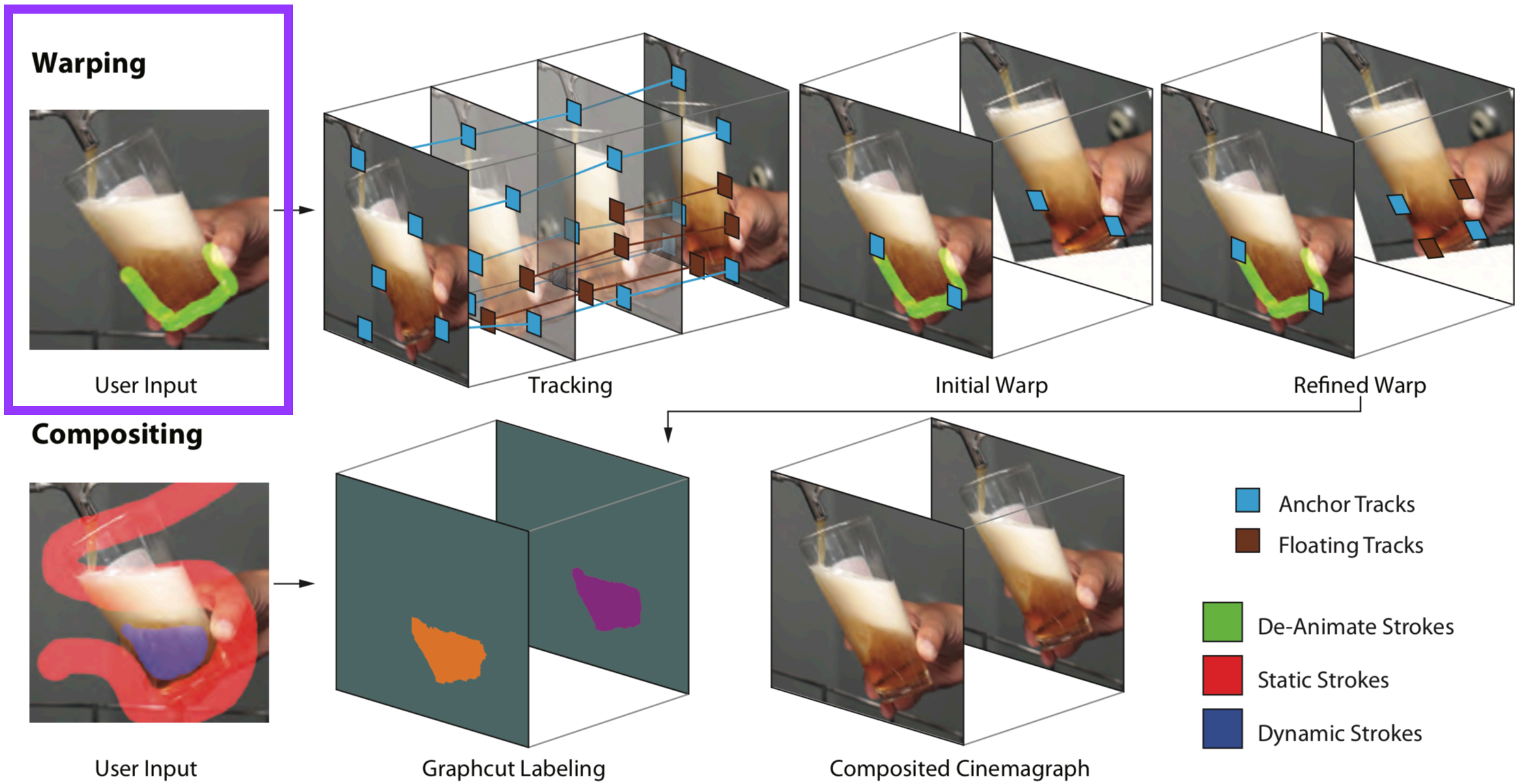
Input Video

Final Result

System Diagram



System Diagram



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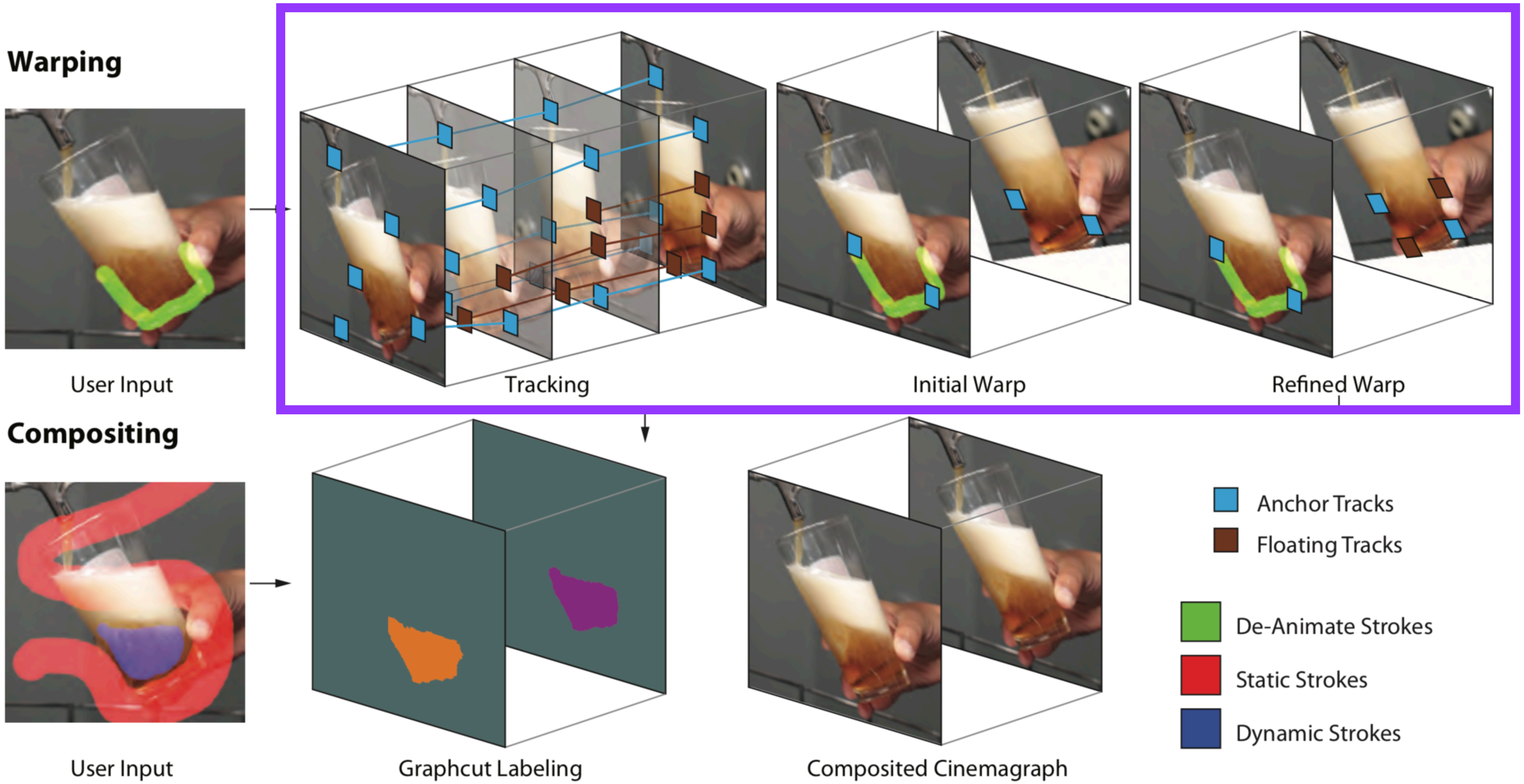
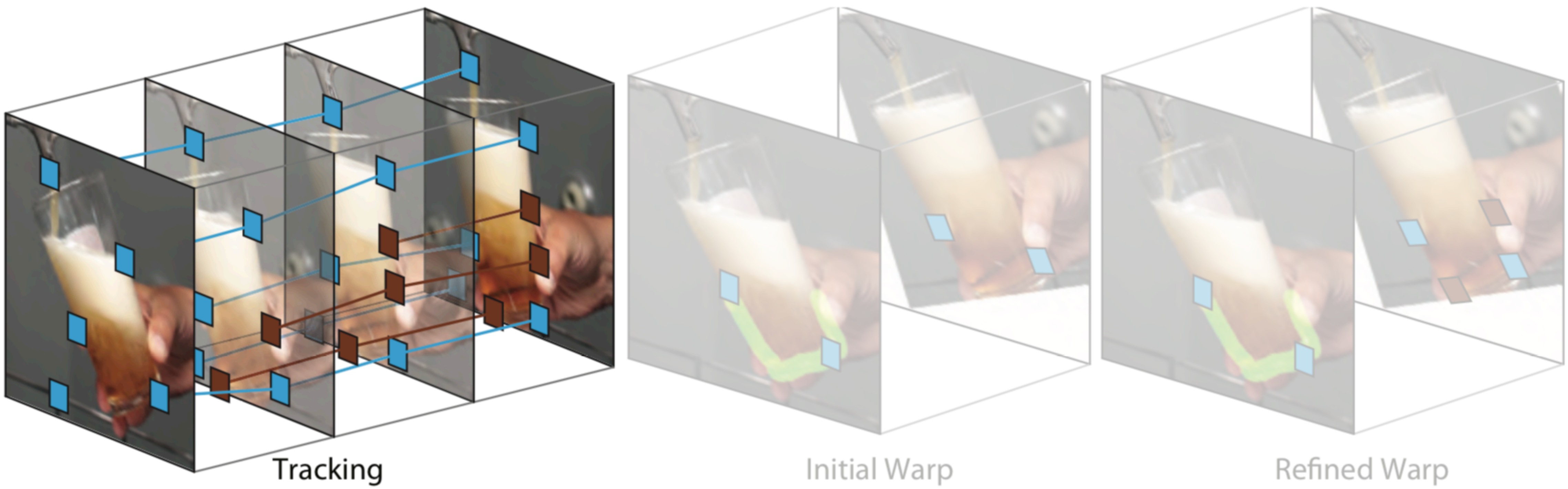


Warping: Tracking



K (s, t) = set of tracks as a table of 2D coordinates

s = track index
t = time (frame number)

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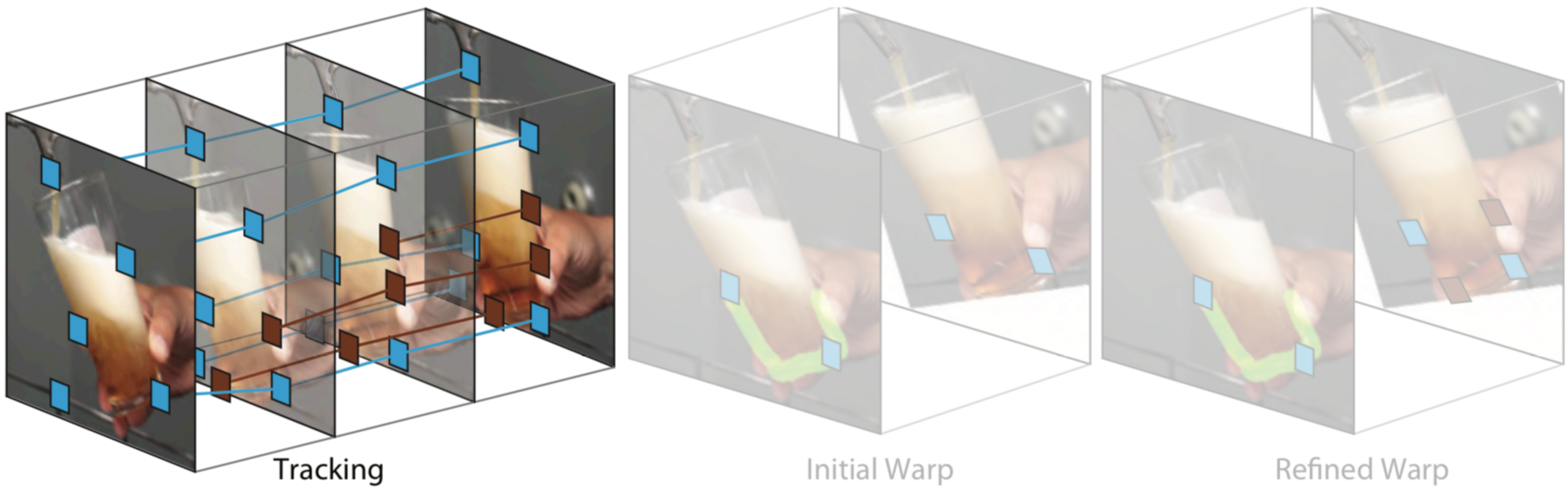

$K(s, t)$ = set of tracks as a table of 2D coordinates

$K_G(s, t)$ = subset of tracks that lie on the user indicated region

$K'_G(s, t)$ = locations of tracks after warping

$K'_G(s, t) = K_G(s, t_a)$

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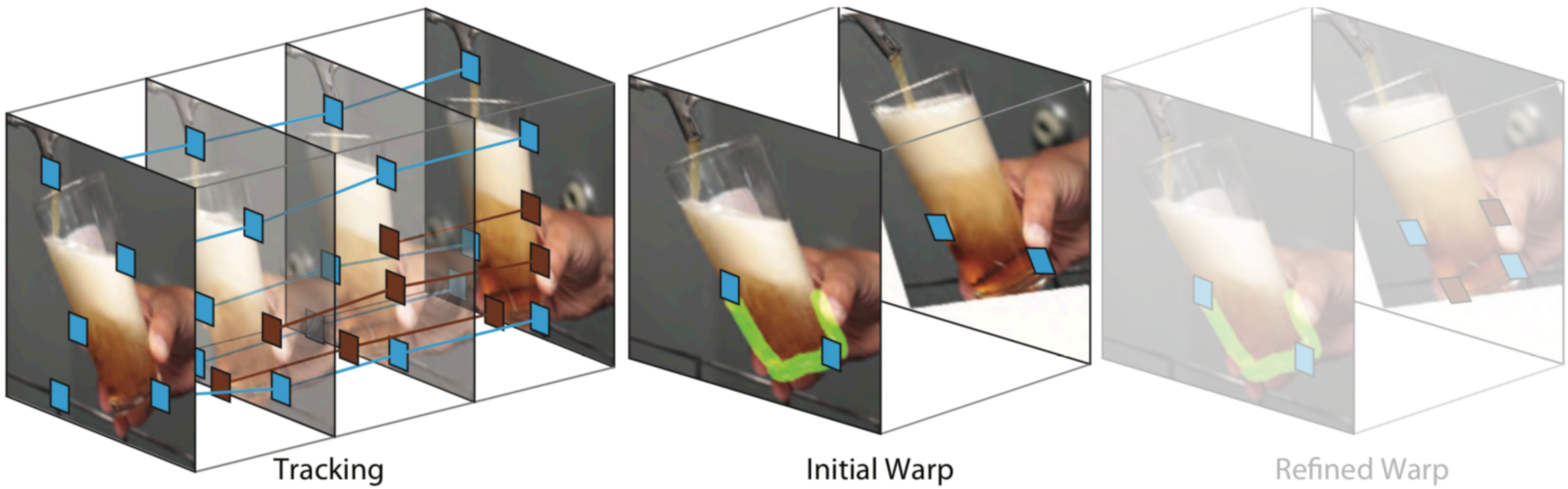

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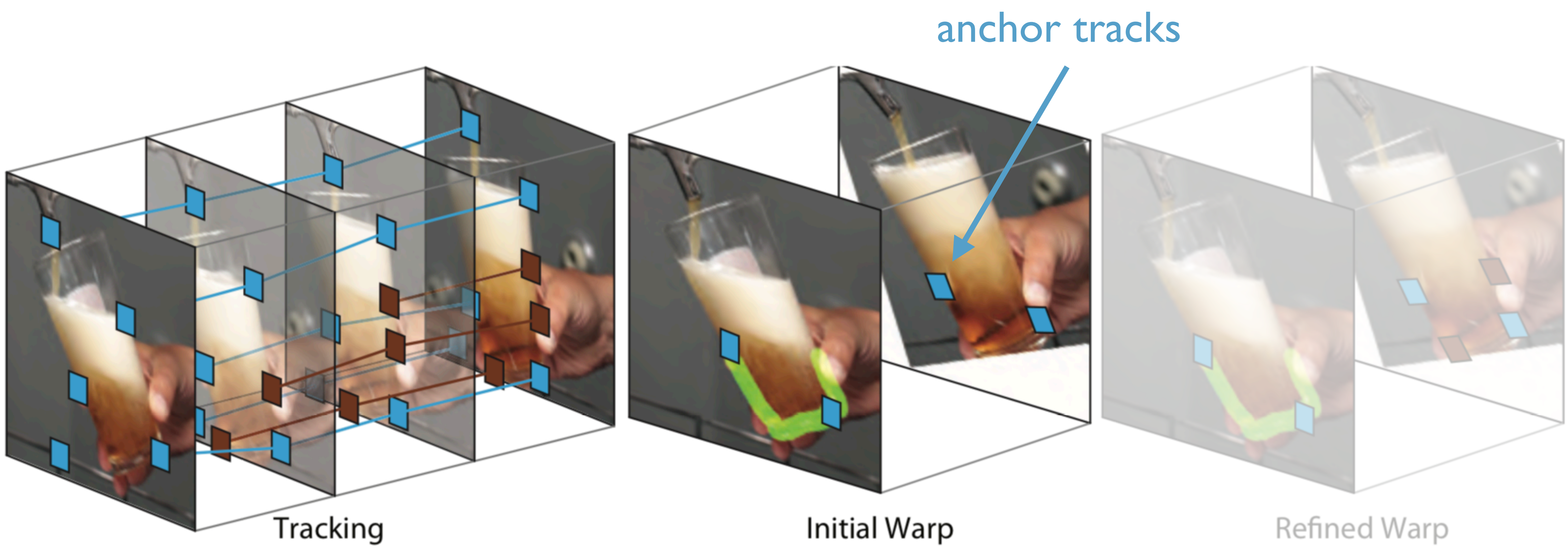

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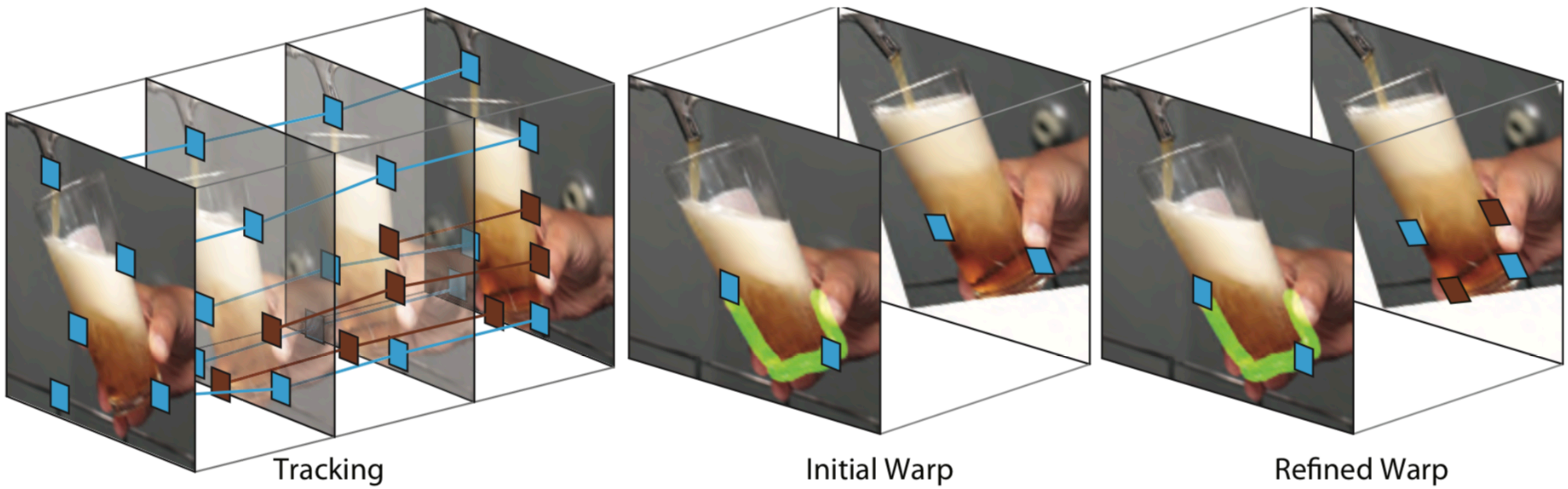

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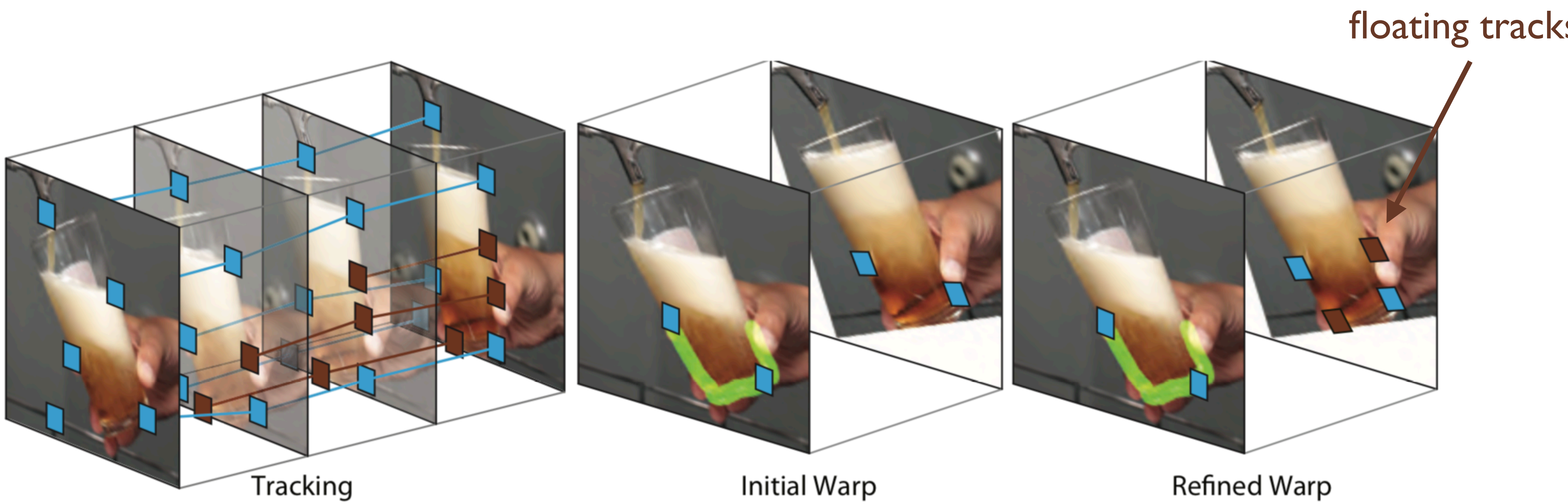

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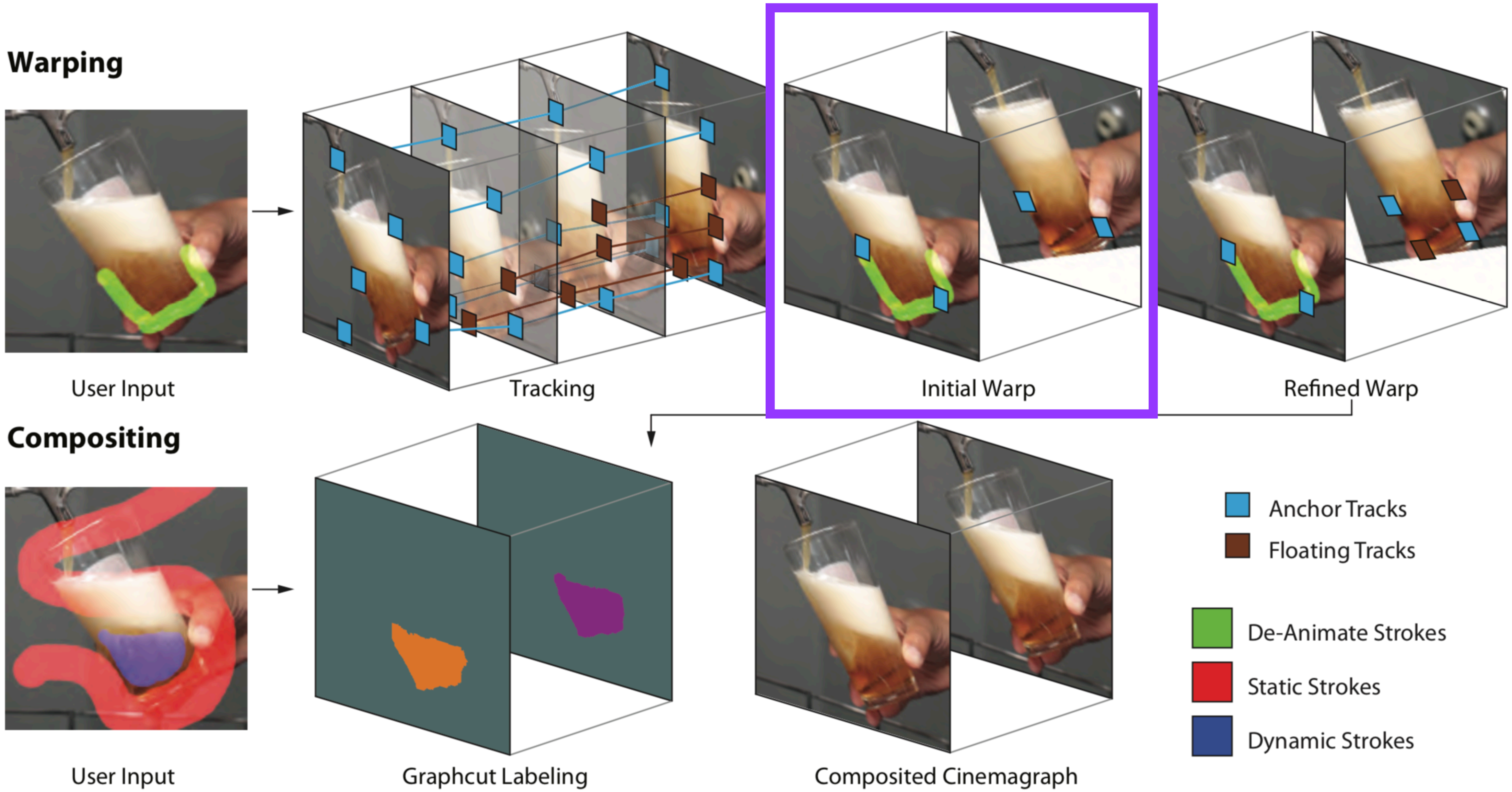

Warping: Initial Warp

$$E = E_a + \omega E_s$$

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main constraint

Warping: Initial Warp

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shape-preserving

Warping: Initial Warp

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$$\boxed{E(\hat{V}) = E_d(\hat{V}) + \alpha E_s(\hat{V}),}$$

Warping: Initial Warp

$$E = E_a + \omega E_s$$

$$E_a = \sum_{s \in K_A, t} l(s,t) \left| K_A(s, t_a) - \mathbf{w}(s,t) \cdot \mathbf{V}'(s,t) \right|^2$$

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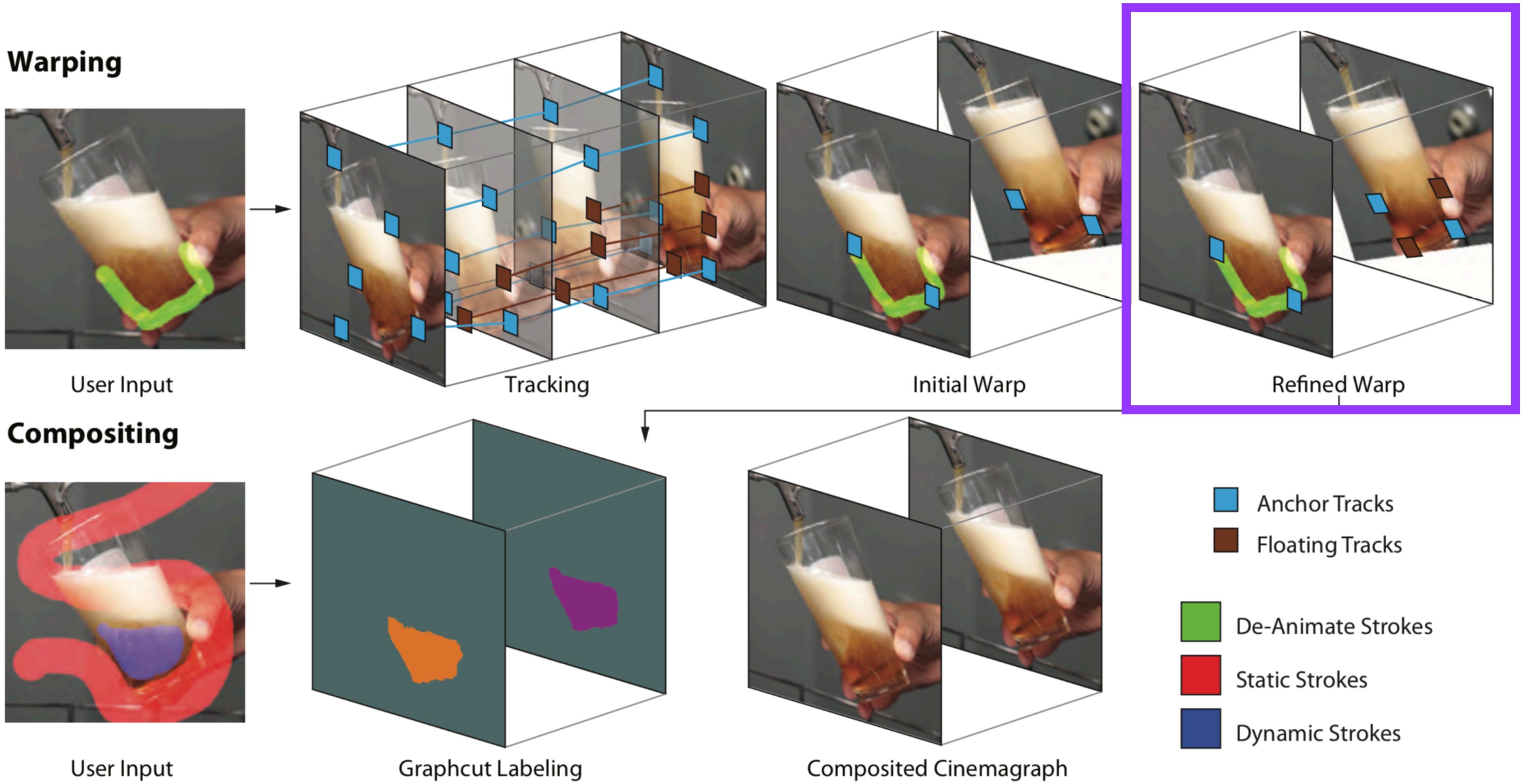
weighting function

System Diagram



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$K'_F\ (s, t_a)$???

Warping: Refined Warp

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Warping: Refined Warp

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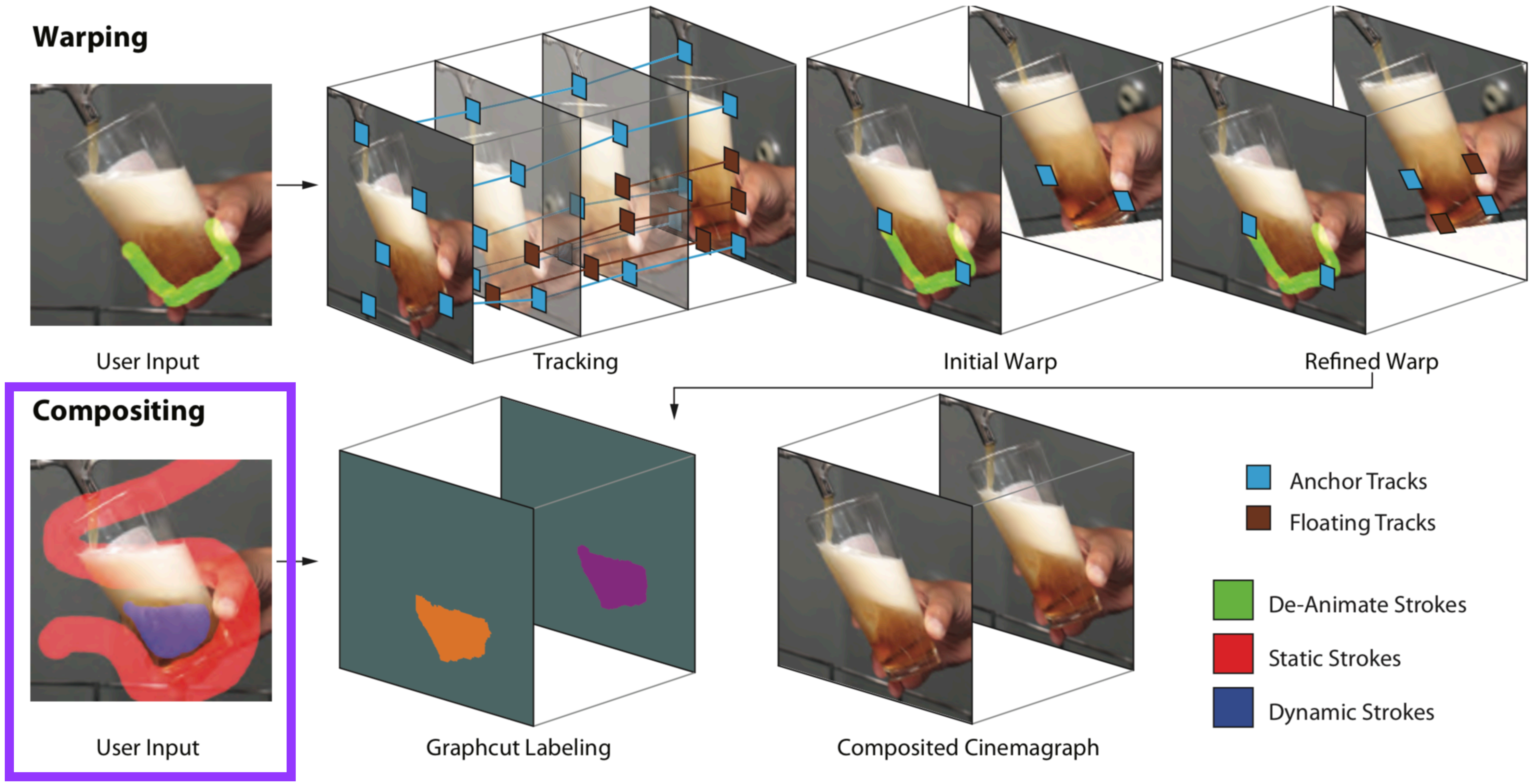
Warping: Result

Input Sequence

Our Warped Video

System Diagram



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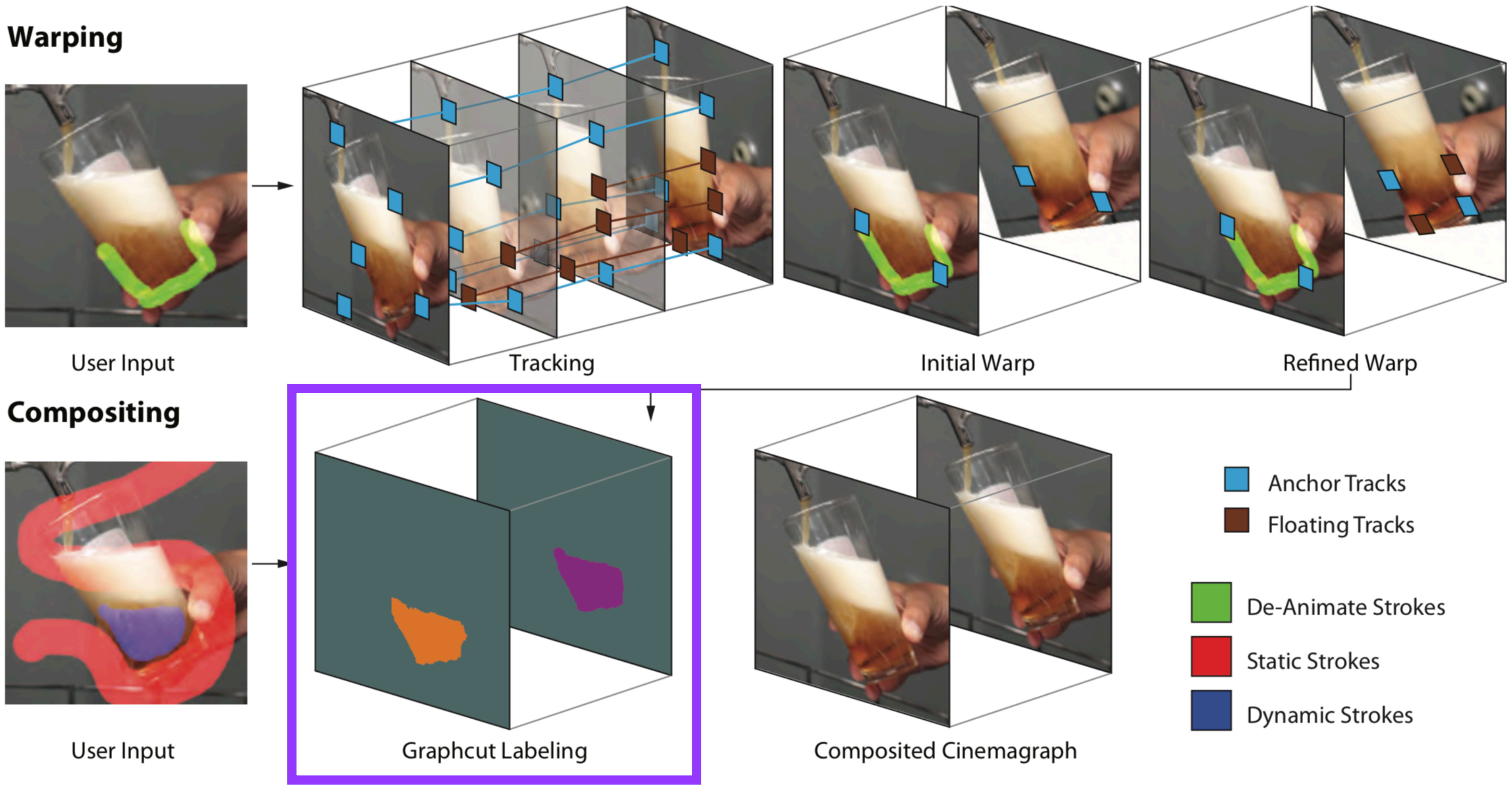

Candidate Video Volumes

Labels L = W U S

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dynamic: copies of warped video $W(x, y, t)$

$W = \{W\}$ or $\{W_i, W_j\}$ (if loop seamlessly)

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static: still-frames from input video repeated to fill duration of output

$S = \{I_b, I_{2b}, \ldots\ I_{5b}\}$

b = time interval that evenly samples the input five times
I_b = video where both frame of input video is repeated for duration of output

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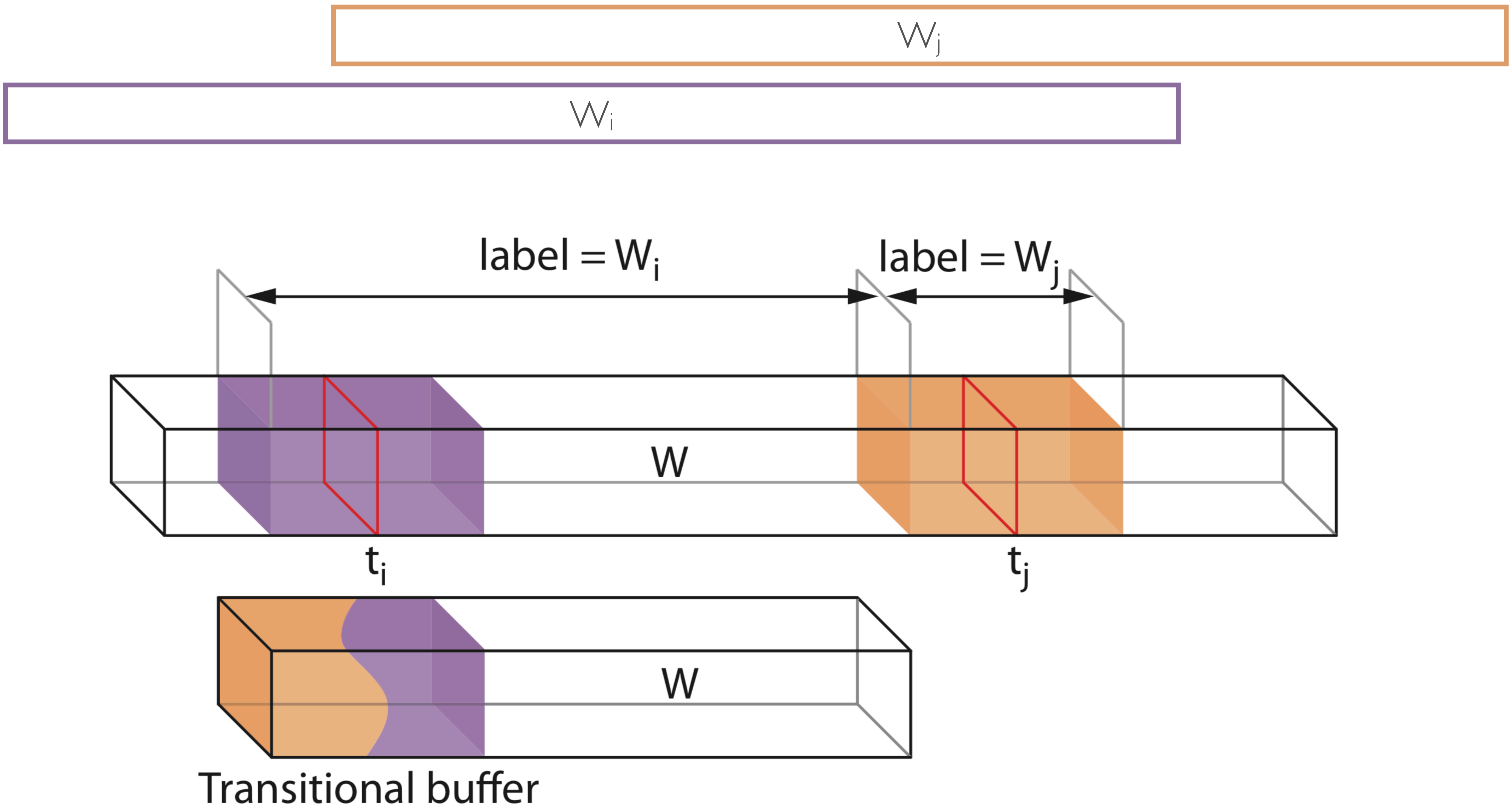
or "clean plate"

Compositing: Graph-cut



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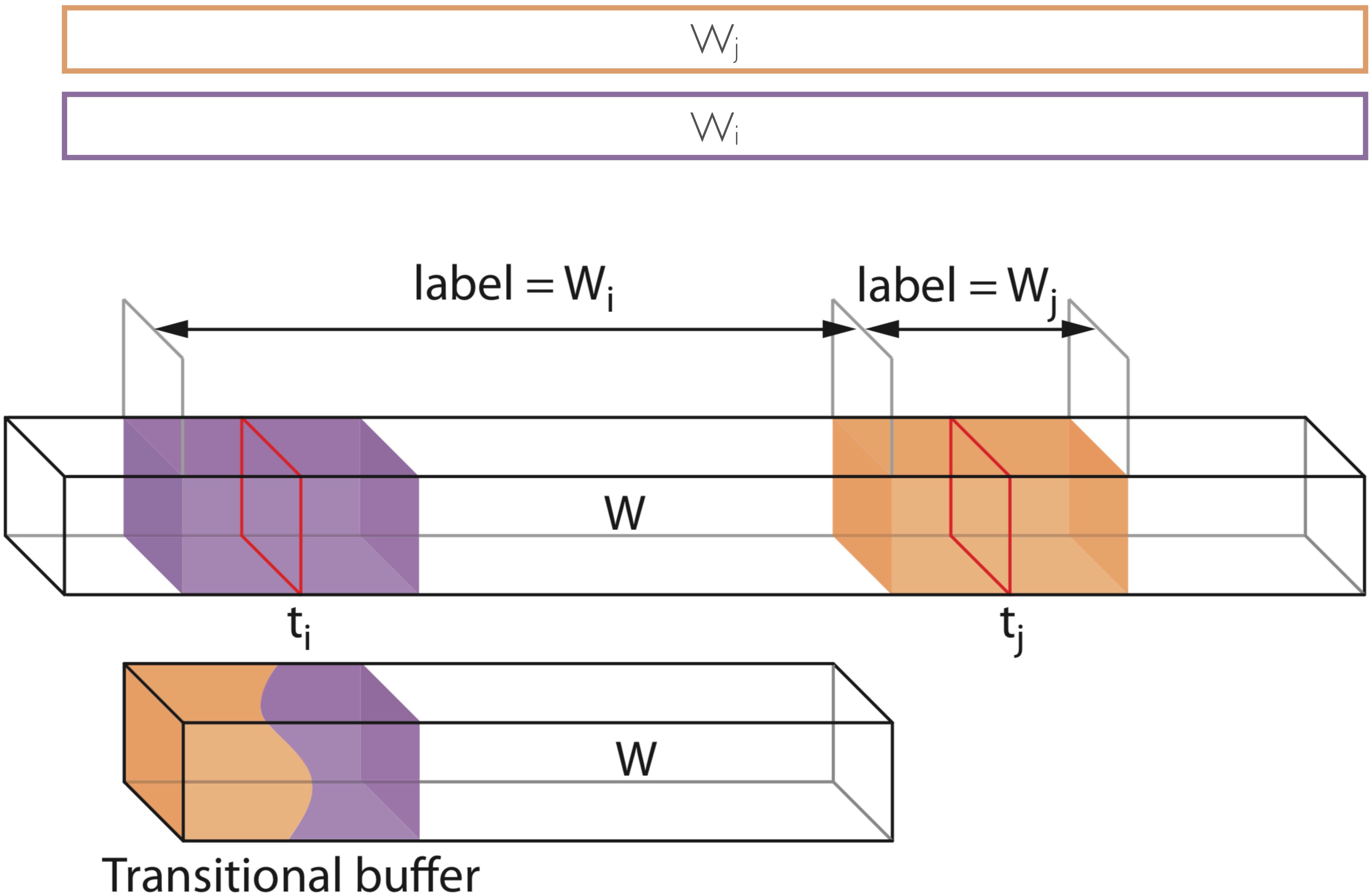

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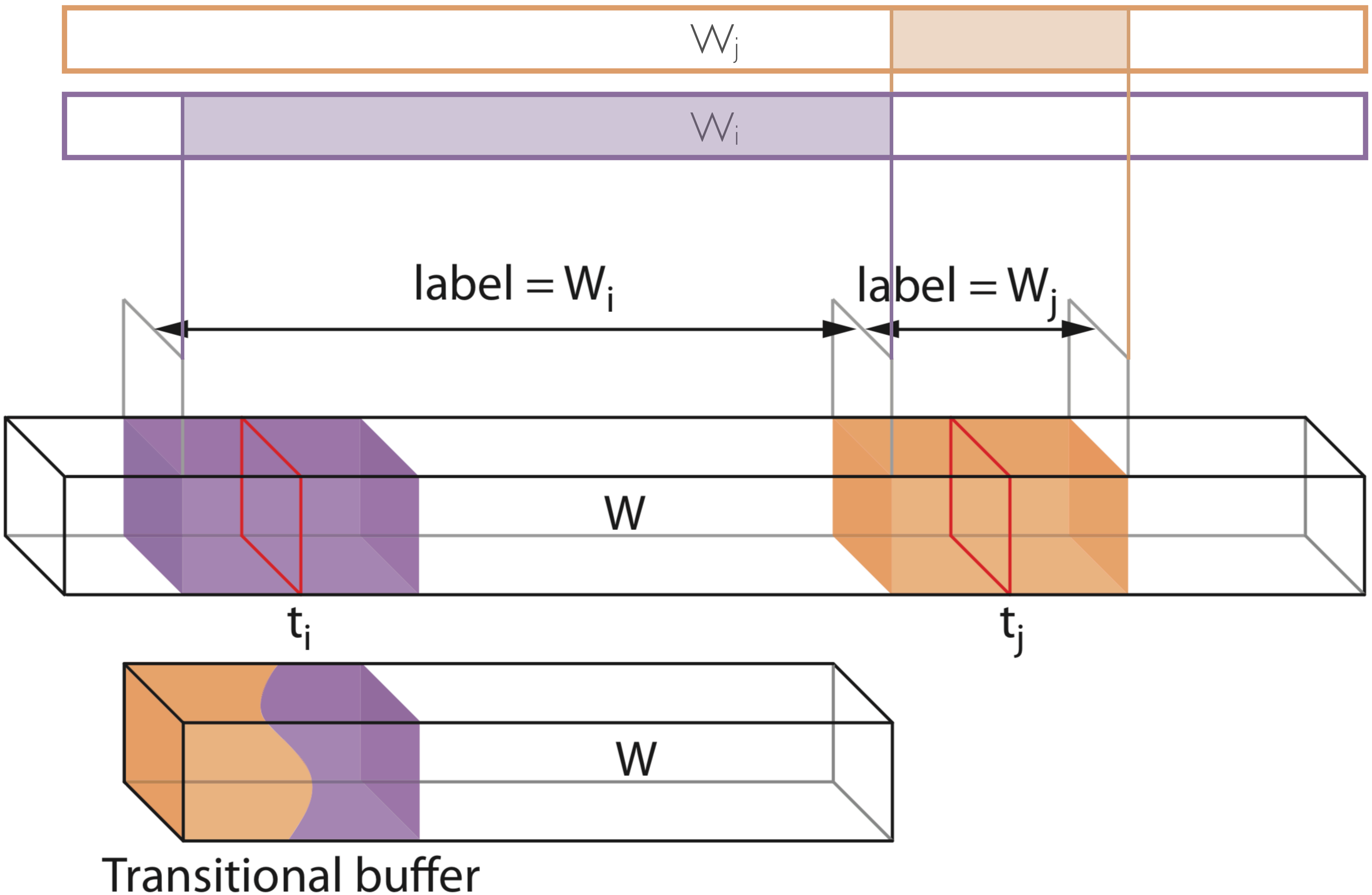

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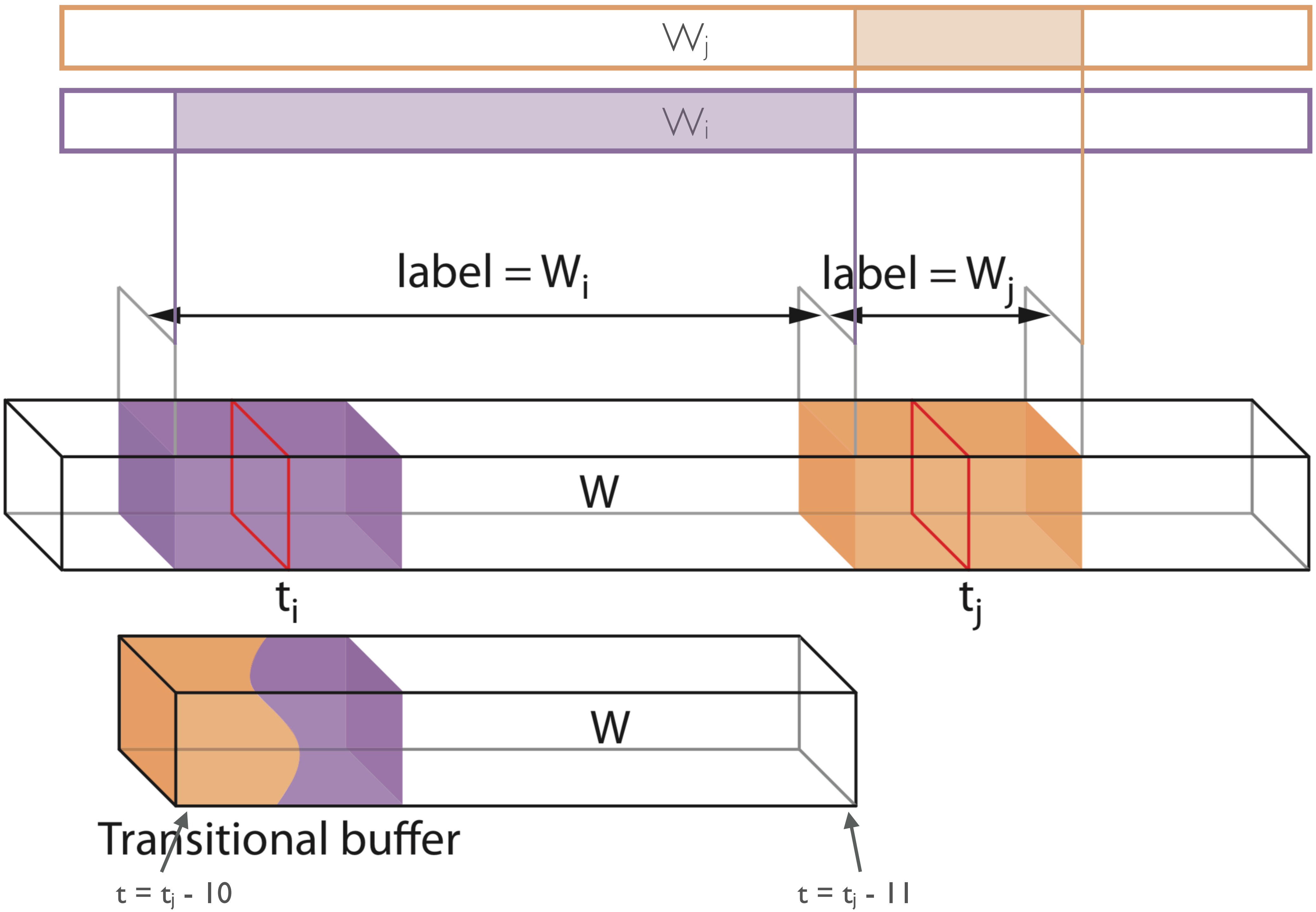

Compositing: Labeling Constraints

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From user-drawn compositing strokes:

- If $v(x, y) =$ **blue**, $\boldsymbol{\lambda}(x, y, t) \in W$
- If $v(x, y) =$ **red**, $\boldsymbol{\lambda}(x, y, t) \in S$

$v(x, y) =$ strokes $\{$red, blue, NULL$\}$

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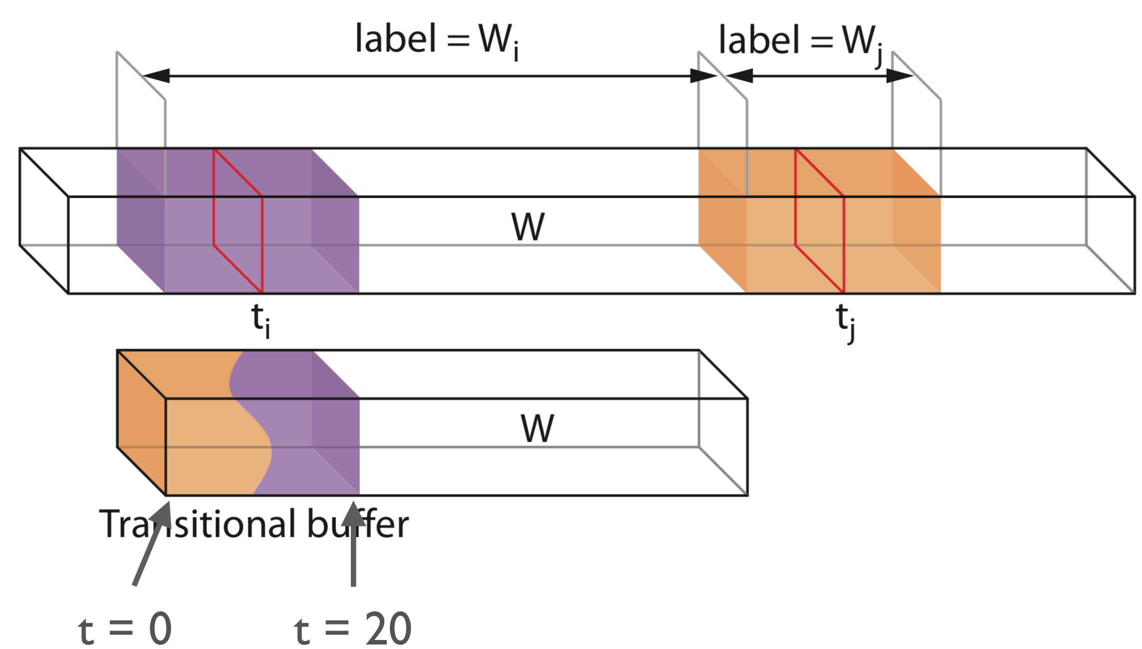
For seamless looping:

- $\lambda(x, y, 0) \neq W_i$
- $\lambda(x, y, 20) \neq W_j$



Compositing: Energy Function

$$\Phi(p_1, p_2, \lambda_1, \lambda_2) = \frac{\gamma(p_1, p_2, \lambda_1, \lambda_2)}{Z(p_1, p_2, \lambda_1, \lambda_2)}$$

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RGB differences

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edge strengths

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$$\begin{aligned}\gamma(p_1, p_2, \lambda_1, \lambda_2) &= |C(p_1, \lambda_1) - C(p_1, \lambda_2)|^2 \\ &+ |C(p_2, \lambda_1) - C(p_2, \lambda_2)|^2\end{aligned}$$

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color of pixel p_2 in candidate video volume $\lambda(p_1)$

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$$Z(p_1, p_2, \lambda_1, \lambda_2) = \begin{cases} \sigma(p_1, p_2, \lambda_1) & \lambda_1 \in \mathbf{W} \wedge \lambda_2 \in \mathbf{S} \\ \sigma(p_1, p_2, \lambda_2) & \lambda_1 \in \mathbf{S} \wedge \lambda_2 \in \mathbf{W} \\ \frac{1}{2}[\sigma(p_1, p_2, \lambda_1) + \sigma(p_1, p_2, \lambda_2)] & \text{Otherwise} \end{cases}$$

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$$Z(p_1, p_2, \lambda_1, \lambda_2) =$$

only consider dynamic candidates for seams between dynamic and static

$$\begin{cases} \boxed{\sigma(p_1, p_2, \lambda_1)} & \lambda_1 \in \mathbf{W} \wedge \lambda_2 \in \mathbf{S} \\ \boxed{\sigma(p_1, p_2, \lambda_2)} & \lambda_1 \in \mathbf{S} \wedge \lambda_2 \in \mathbf{W} \\ \frac{1}{2}[\sigma(p_1, p_2, \lambda_1) + \sigma(p_1, p_2, \lambda_2)] & \text{Otherwise} \end{cases}$$

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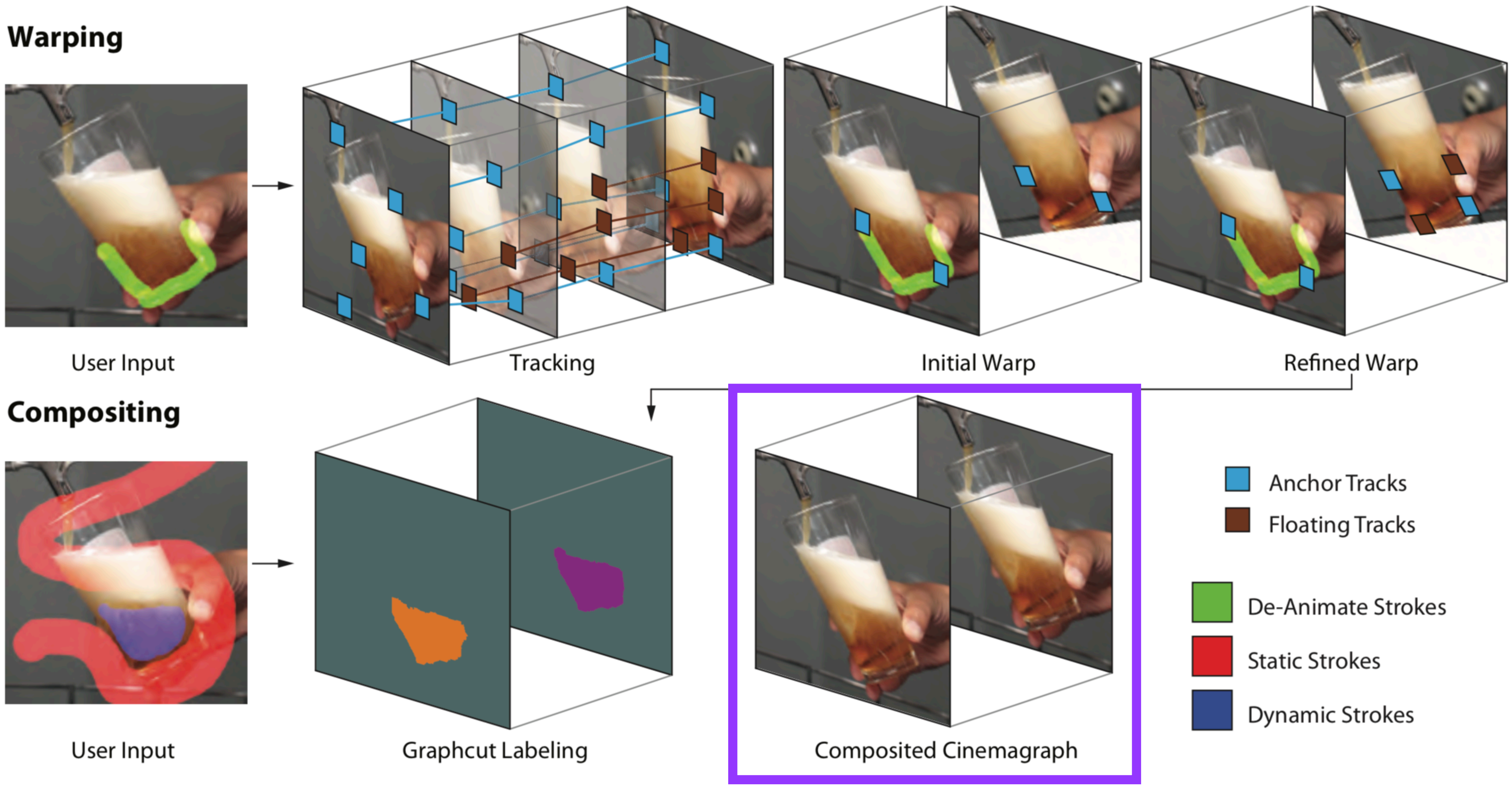
minimize $\displaystyle\sum_{p1,p2} \Phi(p_1, p_2, \lambda_1, \lambda_2)$

System Diagram



Results: Beer

Results: Model K

Input Video

Final Result

Results: Glass


Input Video


Final Result

Results: Glass

Input Sequence

De-Animate Strokes

Results: Glass

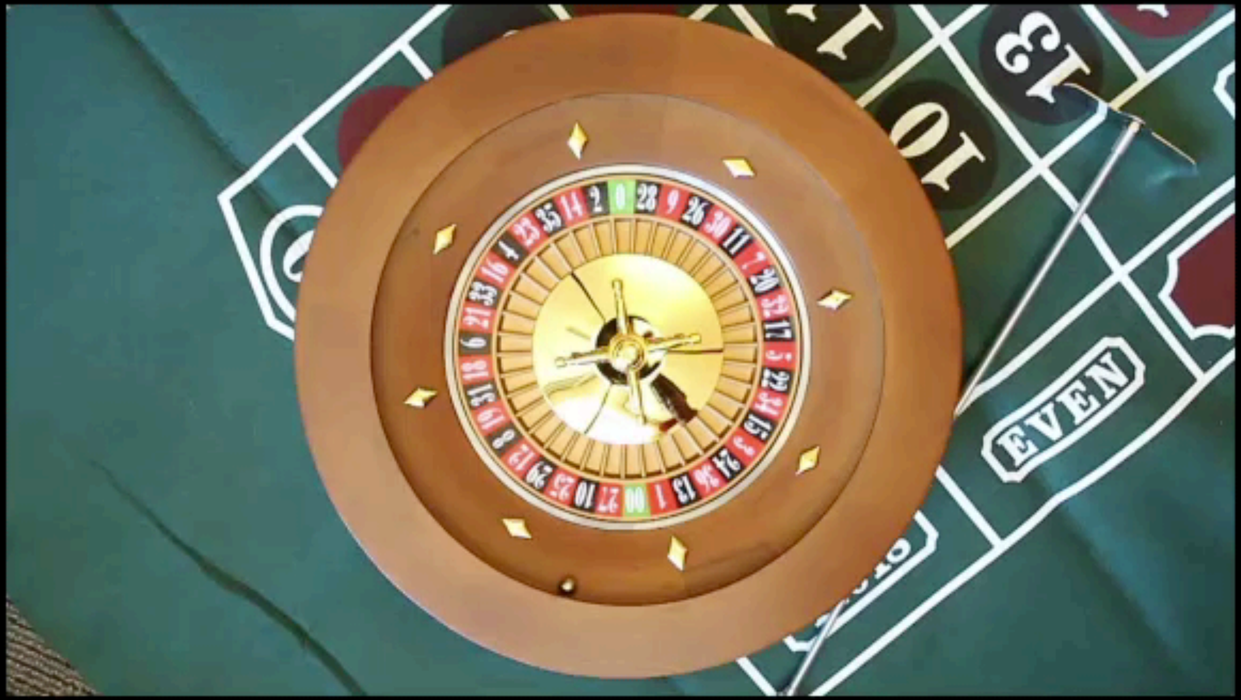
Compositing Strokes

Our Warped Video

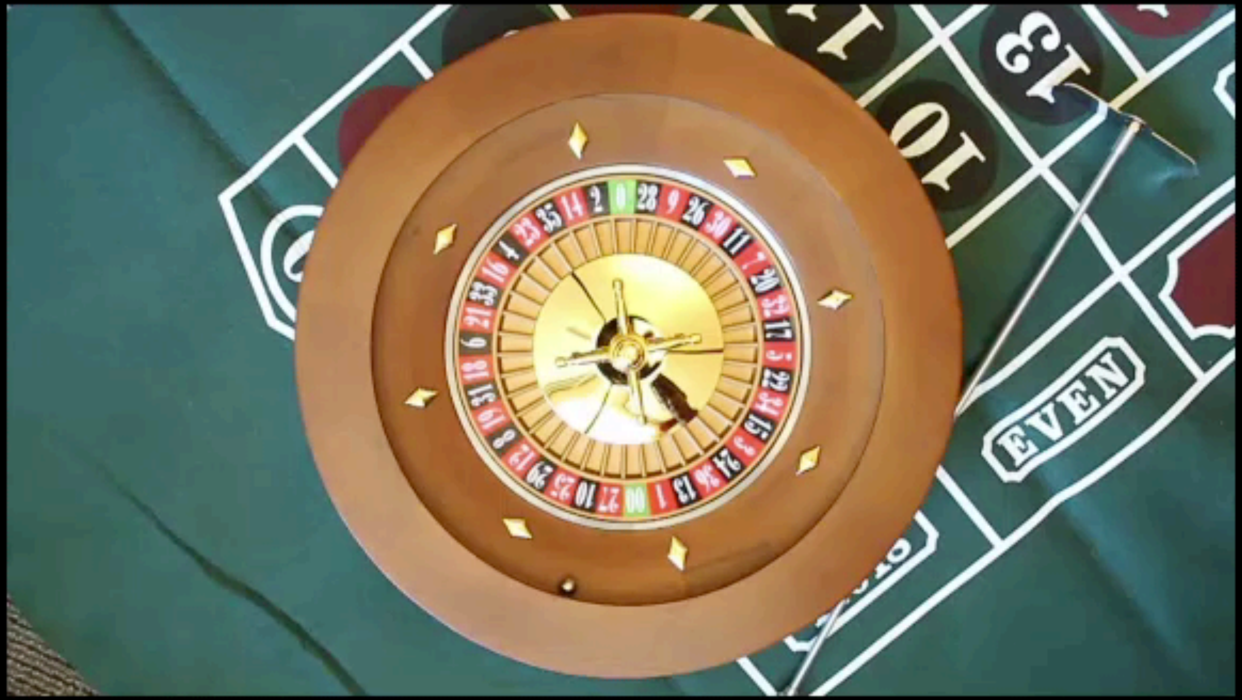
Final Result

Results: Video Editing

Results: Roulette

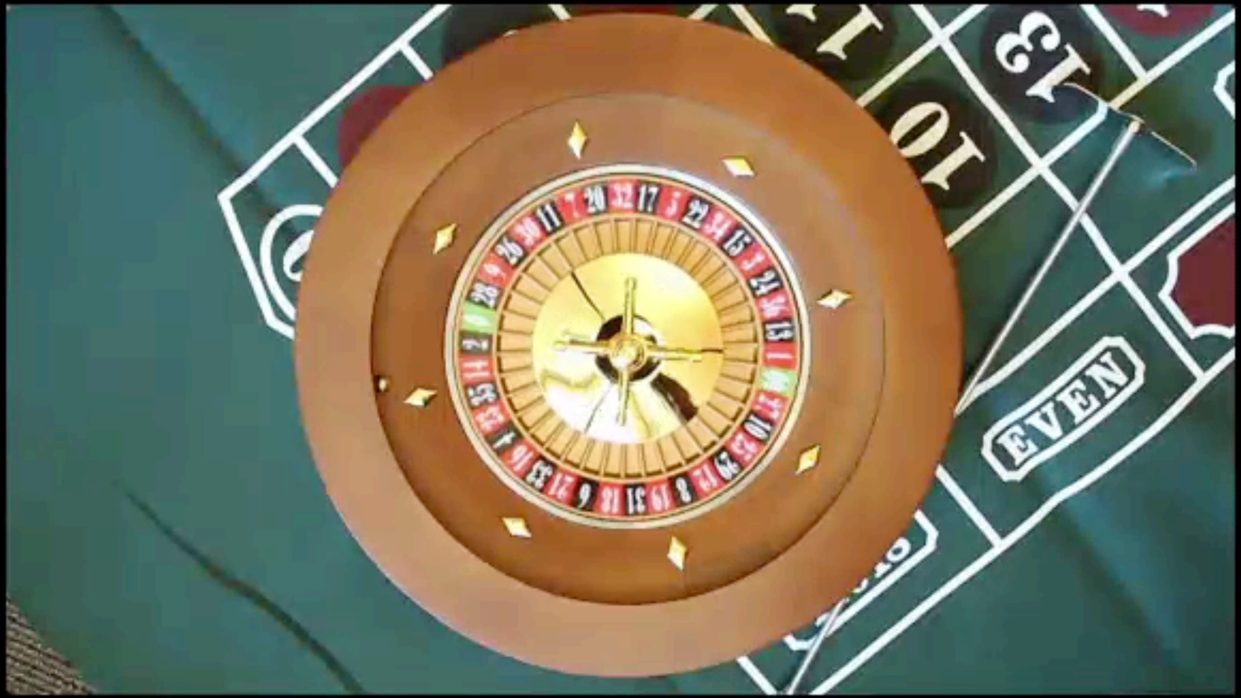


Input Video



Final Result

Results: Roulette



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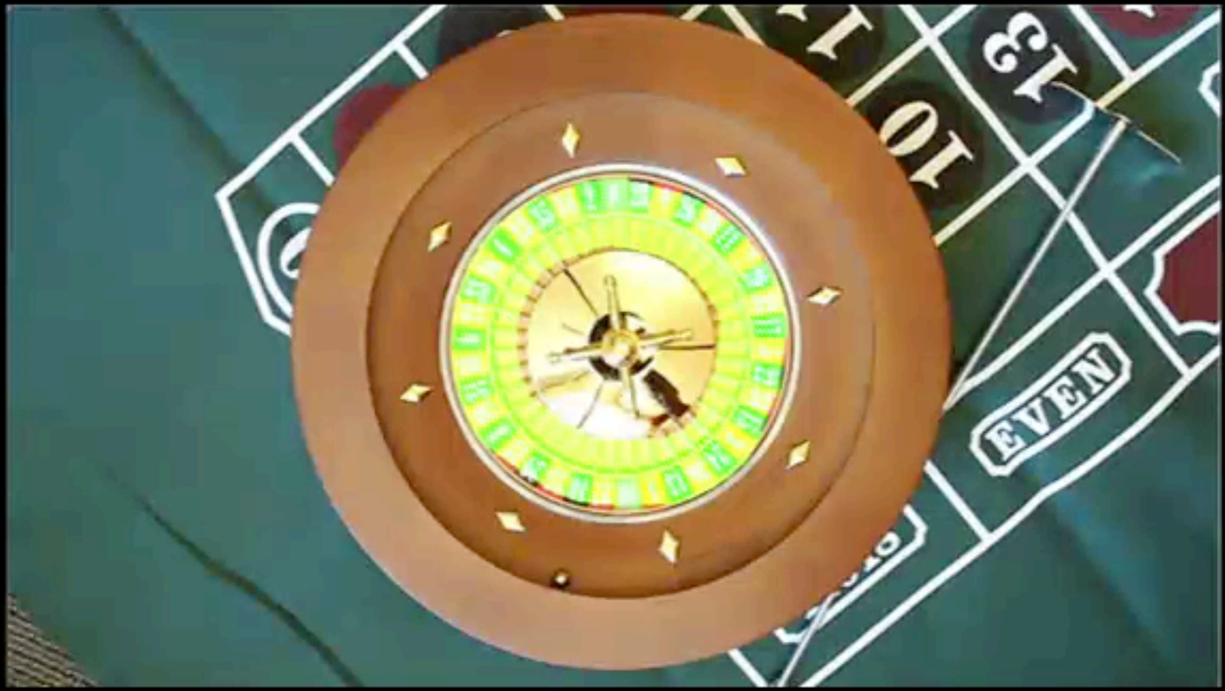


De-Animate Strokes

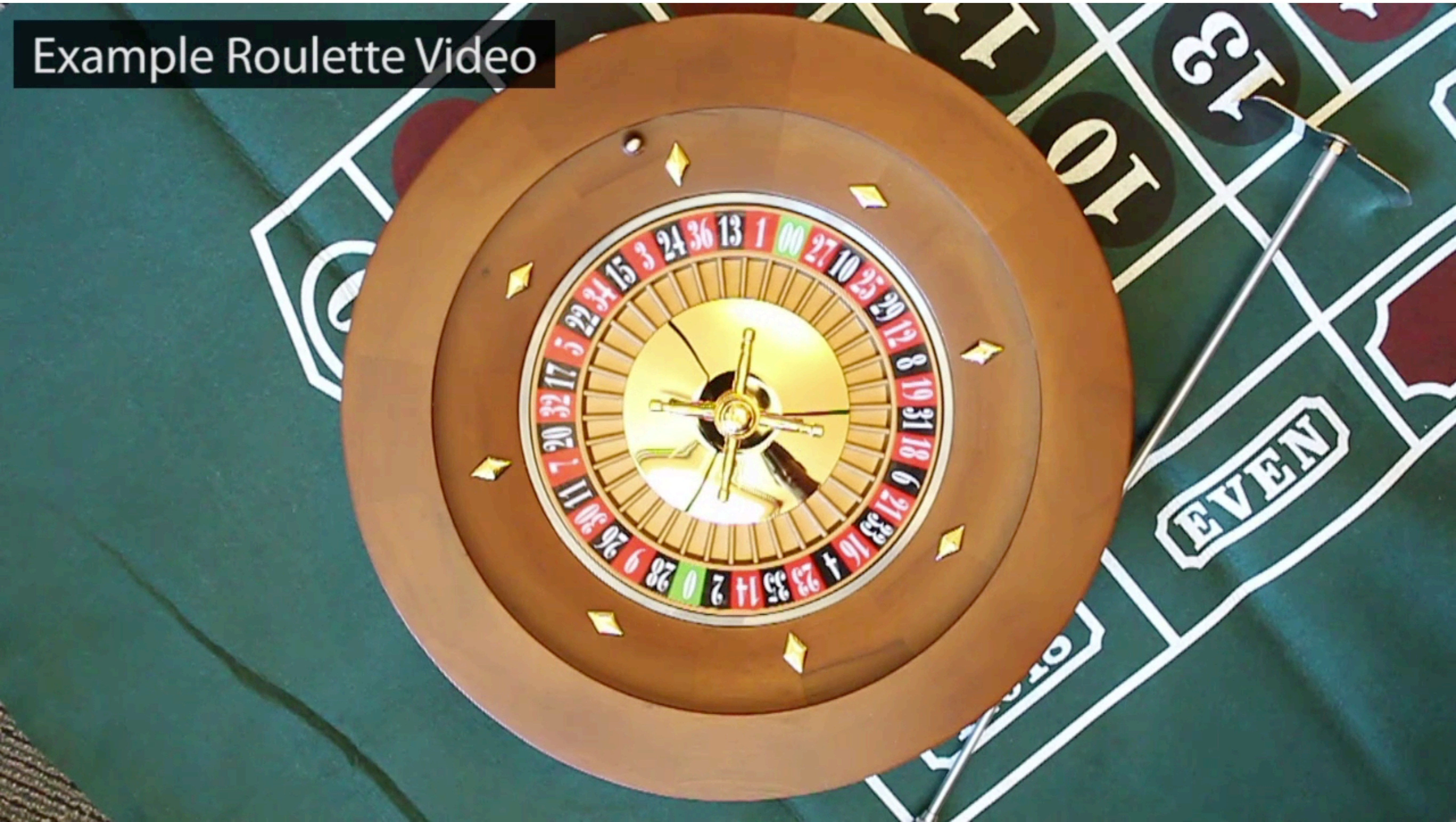
Results: Roulette

Compositing Strokes

Our Warped Video

Final Result

Results: Video Editing



Assumptions

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- Assume large-scale motions can be be de-animated with 2D warps

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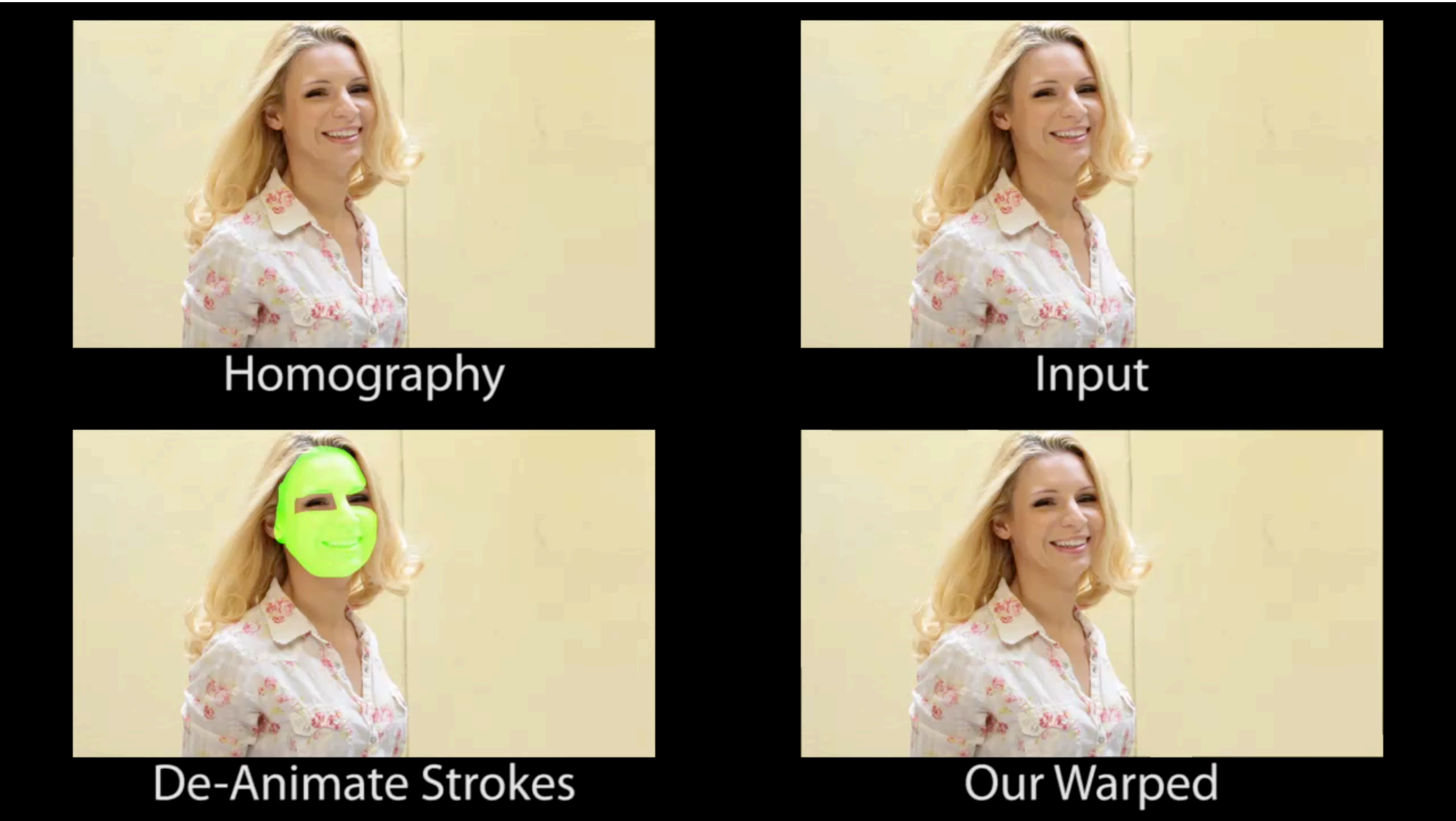
- Objects to de-animate shot in front of a defocused, uniform, or uniformly-textured background

Limitations: 3D Motion



Limitations: Background

Hard Constraints

GMM Constraints

Limitations

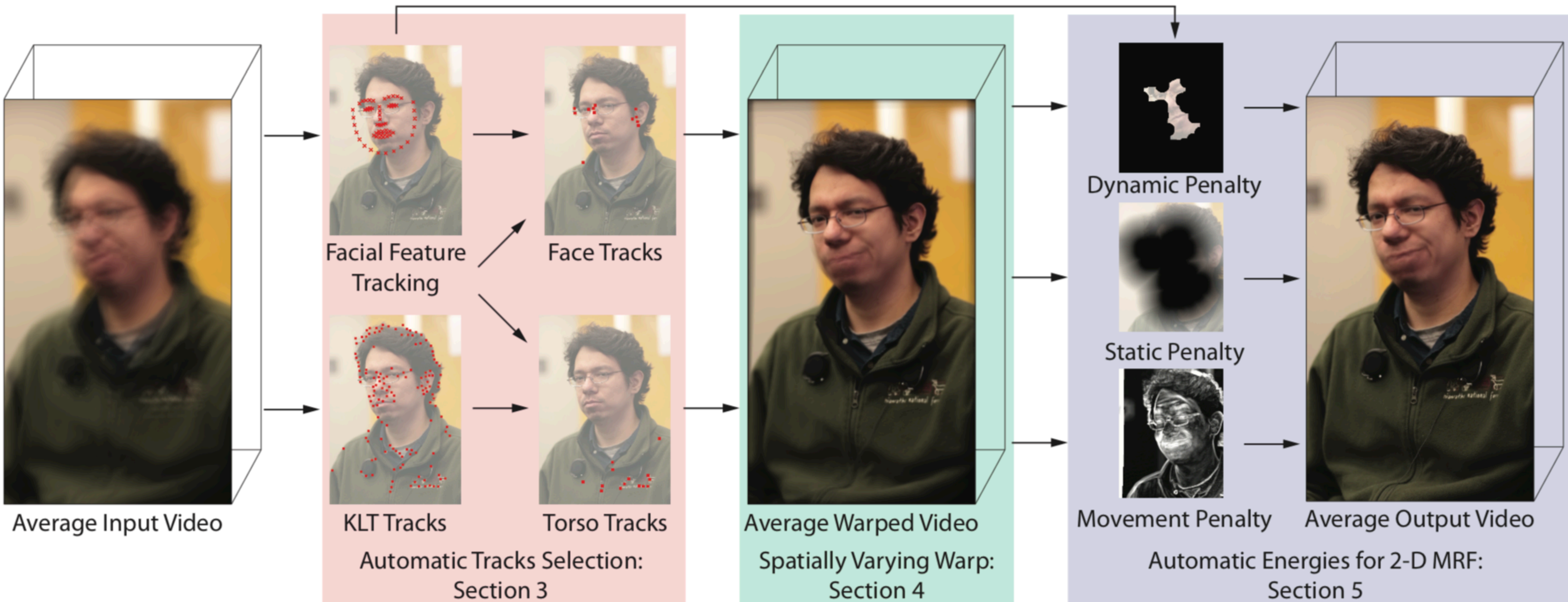
- What happens if the input video is not stabilized?

Follow-up

- This system includes some manual annotation, how would you automate the user input?

- Specifically, what would you do for faces?

Follow-up: Cinemagraph Portraits



"Automatic Cinemagraph Portraits" Bai et al. EGSR 2013

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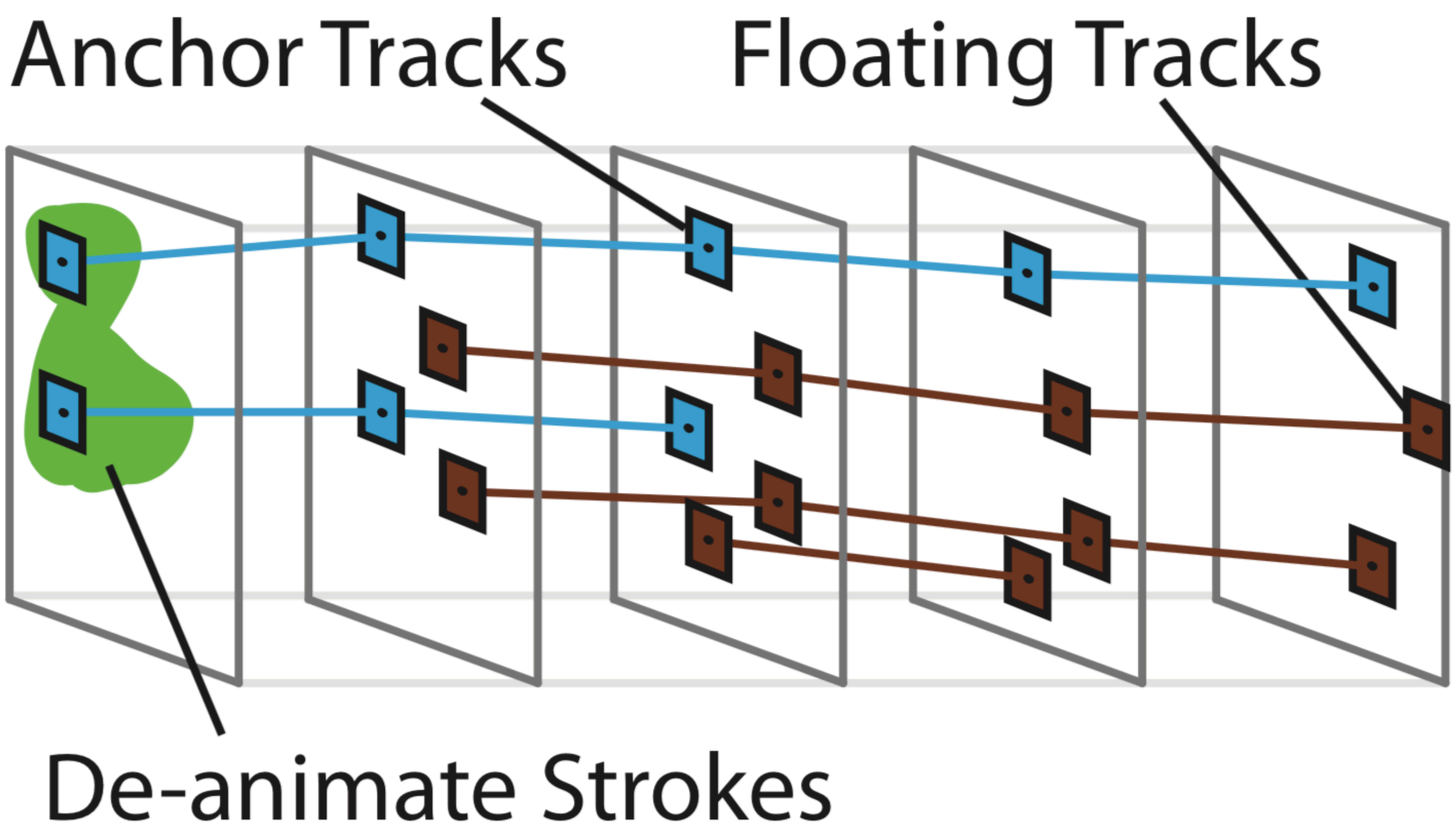
SIGGRAPH 2012

Warping: Tracking



Warping: Initial vs Refined

Results: Existing Techniques

Warp Stabilizer

Our Warped Video

Adapted Cost Function

$$M'(s,t,\mathbf{A},\mathbf{B}) = \frac{M(s,t,\mathbf{A},\mathbf{B})}{\|\mathbf{G}^d_{\mathbf{A}}(s)\| + \|\mathbf{G}^d_{\mathbf{A}}(t)\| + \|\mathbf{G}^d_{\mathbf{B}}(s)\| + \|\mathbf{G}^d_{\mathbf{B}}(t)\|} \quad (5)$$

Graph-cut

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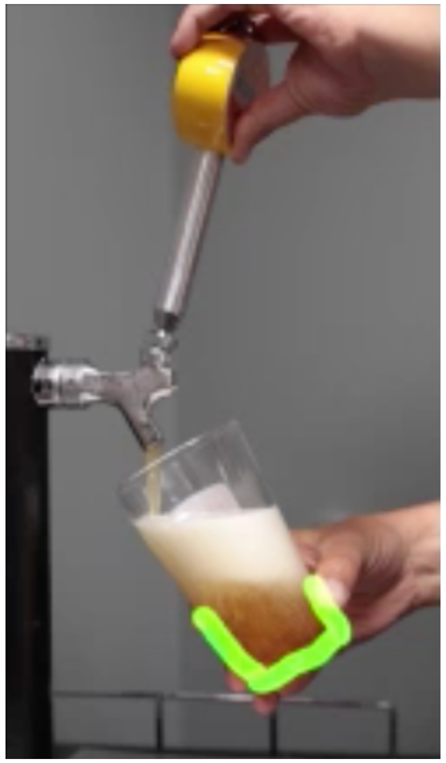
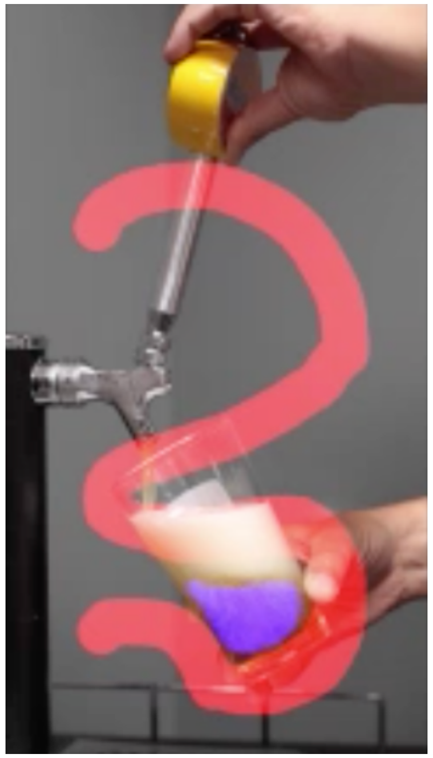
User Input: De-animated Static



de-animate strokes



compositing strokes

User Input: De-animated Dynamic

de-animate strokes

compositing strokes

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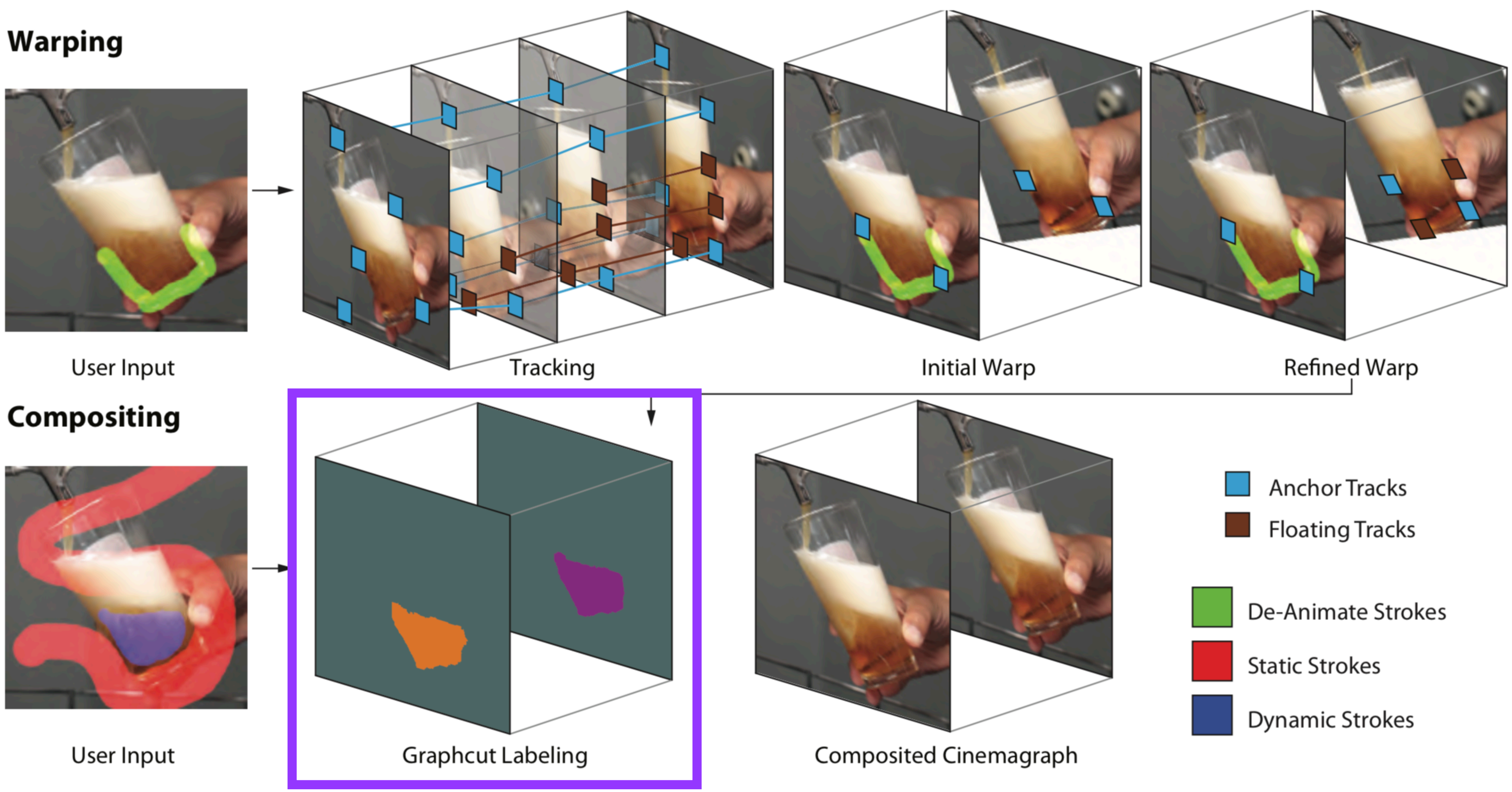

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