TransCut: Transparent Object Segmentation from a Light-Field Image

Supplementary Material

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Outline

• In this supplementary material, we first show the pipeline of the proposed method. The process steps with related equations will be shown in the pipeline.

• Full relationship between the occlusion detector and boundary weight $w_{p,q}$ will be listed.

• Then we demonstrate additional experimental results, including single and multiple objects segmentation with lab setting and real scenes. The results are compared with those given by Finding glass [1] and LF-linearity thresholding method.
Pipeline

Light-field image

Optical flow [2]

Corresponding points

Eq.6 $c(s, t, u, v) = \begin{cases} 0, & e(s, t, u, v) < \tau \\ 1, & e(s, t, u, v) \geq \tau \end{cases}$

LF-consistency

Occlusion detector

LFD feature

Eq.1 $\text{LFD}(u, v) = \{(s, t, \Delta u, \Delta v) | (s, t) \neq (0, 0)\}$

LF-linearity

Eq.4 \[
\begin{pmatrix}
( s, t, \Delta u, \Delta v)_1 \\
( s, t, \Delta u, \Delta v)_2 \\
\vdots \\
( s, t, \Delta u, \Delta v)_M \\
\end{pmatrix}
\begin{pmatrix}
n_1 \\
n_2 \\
n_3 \\
n_4 \\
\end{pmatrix}
= 0.
\]

Occlusion

Eq.13 $R_p(0) = \beta \hat{E}_p \cdot (1 - \hat{O}_p)$

Eq.14 $R_p(1) = \hat{E}_p \cdot \hat{O}_p + (1 - \hat{E}_p)$

Regional term

Graph cut [3]

Boundary term

Segment mask

Eq.17 $B_{p,q}$
Relationship between occlusion detector and $w_{p,q}$

If $\tilde{O}_p$ is from $\tilde{\theta} = 0$,

$$\begin{cases} w_{p,q_1} = \tilde{O}_p \\ w_{p,q_2} = w_{p,q_3} = w_{p,q_4} = 0 \end{cases}$$

If $\tilde{O}_p$ is from $\tilde{\theta} = 45$,

$$\begin{cases} w_{p,q_1} = w_{p,q_2} = \tilde{O}_p / \sqrt{2} \\ w_{p,q_3} = w_{p,q_4} = 0 \end{cases}$$
Relationship between occlusion detector and $w_{p,q}$

If $\tilde{O}_p$ is from $\tilde{\theta} = 90$,\n\[ w_{p,q_2} = \tilde{O}_p \]
\[ w_{p,q_1} = w_{p,q_3} = w_{p,q_4} = 0 \]

If $\tilde{O}_p$ is from $\tilde{\theta} = 135$,\n\[ w_{p,q_2} = w_{p,q_3} = \tilde{O}_p / \sqrt{2} \]
\[ w_{p,q_1} = w_{p,q_4} = 0 \]
Relationship between occlusion detector and $w_{p,q}$

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If $\tilde{O}_p$ is from $\tilde{\theta} = 180$,

\[
\begin{align*}
    w_{p,q_3} &= \tilde{O}_p \\
    w_{p,q_1} &= w_{p,q_2} = w_{p,q_4} = 0
\end{align*}
\]

If $\tilde{O}_p$ is from $\tilde{\theta} = 225$,

\[
\begin{align*}
    w_{p,q_3} &= w_{p,q_4} = \frac{\tilde{O}_p}{\sqrt{2}} \\
    w_{p,q_1} &= w_{p,q_2} = 0
\end{align*}
\]
Relationship between occlusion detector and $w_{p,q}$

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If $\tilde{O}_p$ is from $\tilde{\theta} = 270$, then:

\[
\begin{align*}
    w_{p,q_4} &= \tilde{O}_p \\
    w_{p,q_1} &= w_{p,q_2} = w_{p,q_3} = 0
\end{align*}
\]

If $\tilde{O}_p$ is from $\tilde{\theta} = 315$, then:

\[
\begin{align*}
    w_{p,q_1} &= w_{p,q_4} = \tilde{O}_p / \sqrt{2} \\
    w_{p,q_2} &= w_{p,q_3} = 0
\end{align*}
\]
Experimental results

• We first show the results of single object segmentation. There are seven objects and seven scenes in the single object dataset.

• We then show the results of two objects segmentation. Seven scenes with two different combinations of two objects are used in the experiments.

• We also show the results of real scenes. Four different objects are used in the experiments.

• We tune the parameters in these experiments in order to make them suitable for specific scenes.
Single object

Object 1           Object 2            Object 3           Object 4           Object 5            Object 6           Object 7

Object 1           Object 2            Object 3           Object 4           Object 5            Object 6           Object 7

Scene 1            Scene 2            Scene 3           Scene 4           Scene 5            Scene 6           Scene 7

Scene 1            Scene 2            Scene 3           Scene 4           Scene 5            Scene 6           Scene 7

• All the results processed by Finding glass, LF-linearity thresholding and proposed TransCut method will be demonstrated. The ground truth will be given for comparison.

• The light-field data with ground truth will be released on our website.
Intermediate results

• We show several examples of the intermediate results here. The 2^{nd} and 3^{rd} column show the penalty for background and foreground respectively. The darker color represents lower penalty. And the 4^{th} column shows the maximum response from the occlusion detector, brighter means higher response.
Object 1

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 2

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 3

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 4

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 5

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 6

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Object 7

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut

Ground Truth
Two objects

Object combination 1

Object combination 2

Scene 1

Scene 2

Scene 3

Scene 4

Scene 5

Scene 6

Scene 7

• We show all the results processed by Finding glass, LF-linearity thresholding and proposed TransCut method.
Object combination 1

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut
Object combination 2

Images from the central viewpoint

Results from Finding glass

Results from LF-linearity thresholding

Results from TransCut
Real scene

Images from the central viewpoint

Results from TransCut
References

