Combining Contrast Saliency and Region Discontinuity for Precise Hand Segmentation in Projector-Camera System

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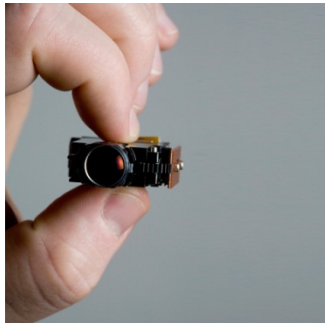
Motivation



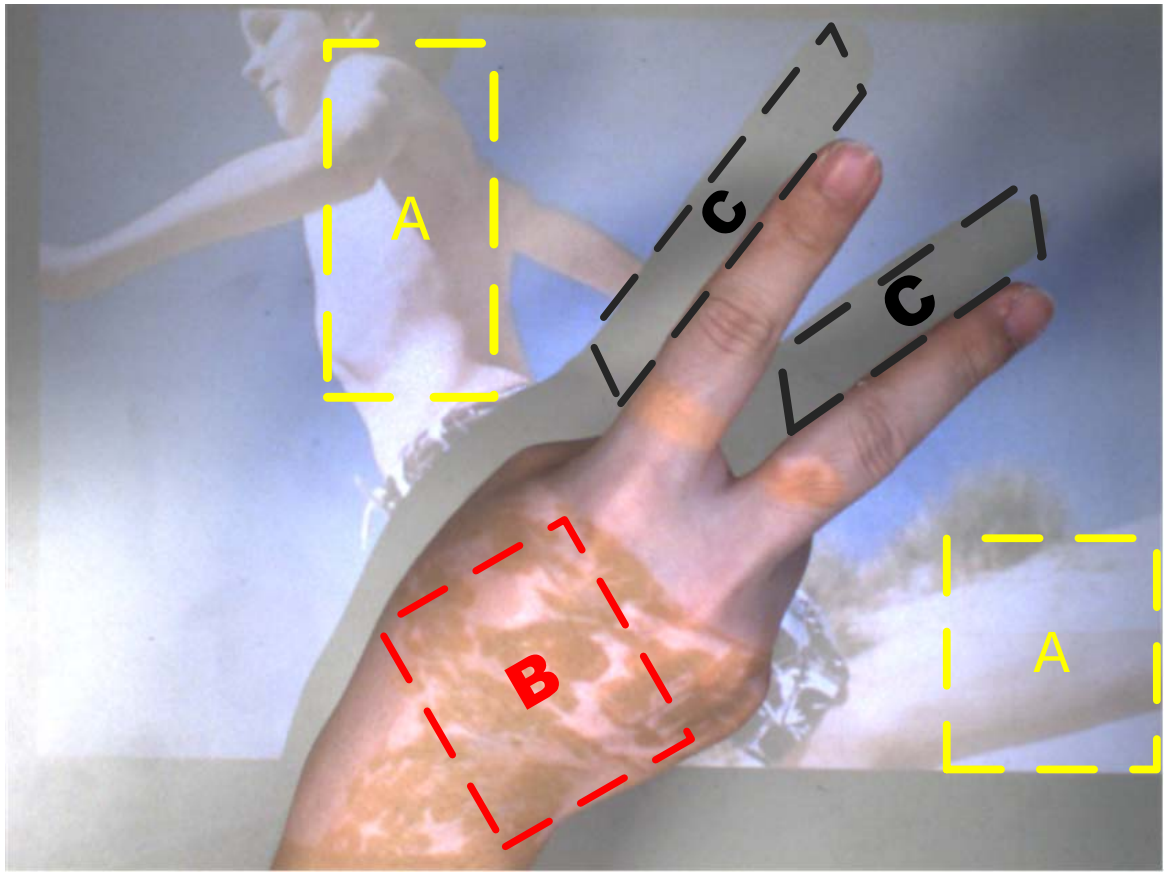
DLP Pico Projector

Mobile Phone

DC

DV

Previews Works



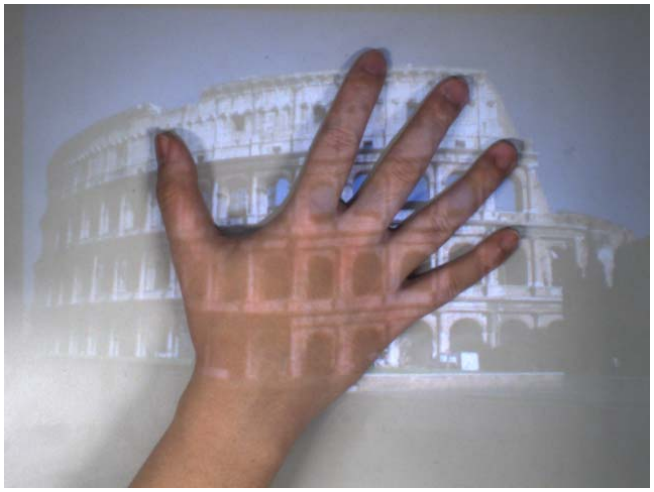
- **Skin-color Detection**
- **Background Subtraction**

Previews Works

- **Graph-based Approaches**
  - *Time Consuming*
  - *User's Interaction*
- **Additional Instruments**
  - *Infrared Camera*
  - *Stereo Camera*
  - *Depth Sensor (Time-of-Fight Camera, Kinect etc.)*
- **Our Method**

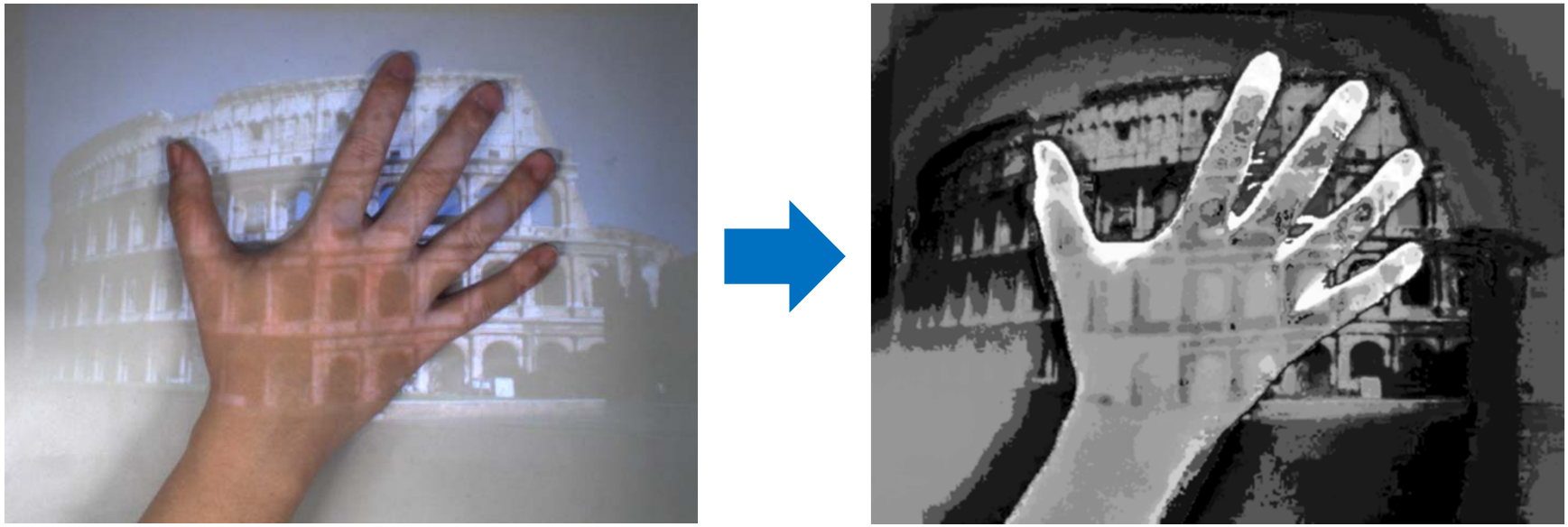
  - ***w/o pre-calibration & pre-training***

Rough Segmentation by Contrast Saliency



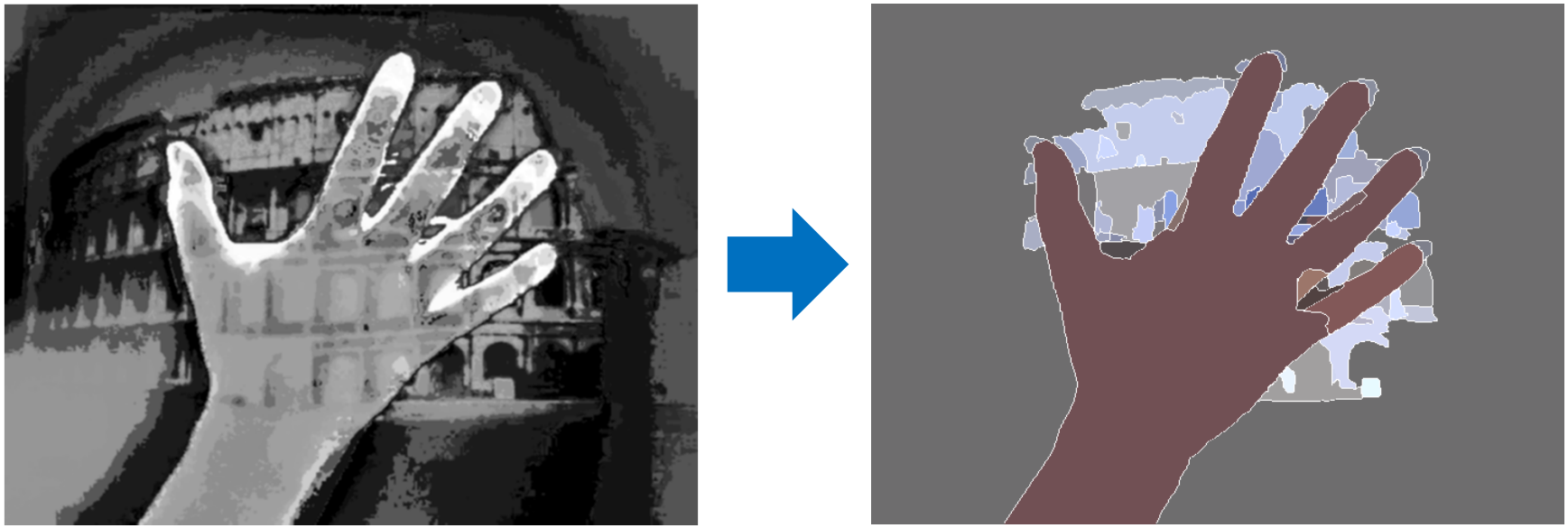
- **Hand - Most *noticeable* object**
- ***Salient* Region Detection**
- **Saliency Detector Requirements:**
  - *Emphasizing the **largest** salient objects*
  - ***Uniformly** highlighting whole salient regions*
  - ***Disregarding artifacts** arising from projection content and ambient illumination*
  - *Accomplishing detection less than **15ms***

Histogram-based Contrast Saliency



- *M. Cheng et al. Global contrast based salient region detection, CVPR2011.*

Mean-Shift Region Smoothing



Precise Segmentation by Fusing

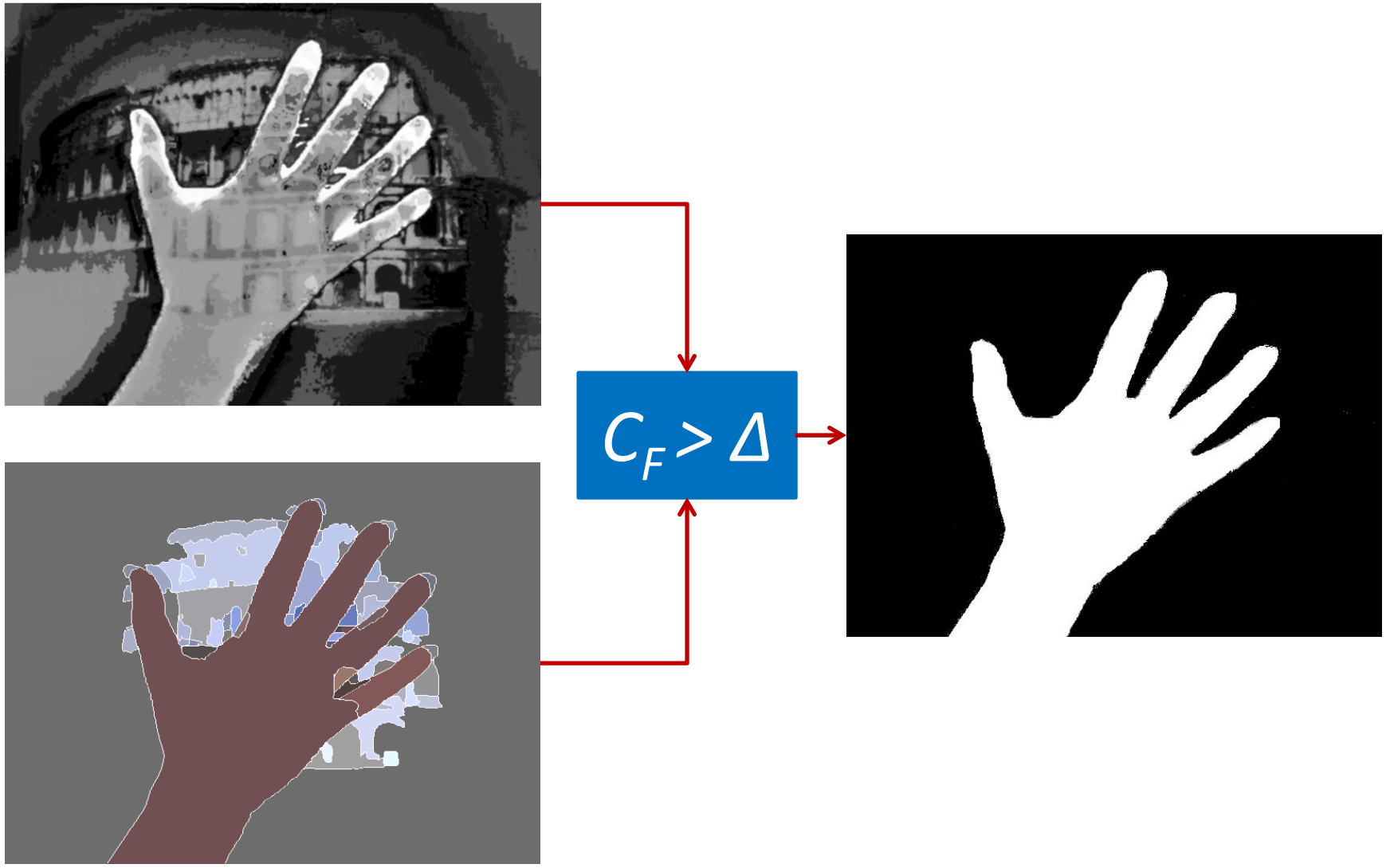
- **Confidence Function**

$$C_F(k) = \frac{1}{e^{(L-1)}}\left[\alpha \bar{S}(k) + \beta \bar{S}_N(k) + \gamma A(k)\right]$$

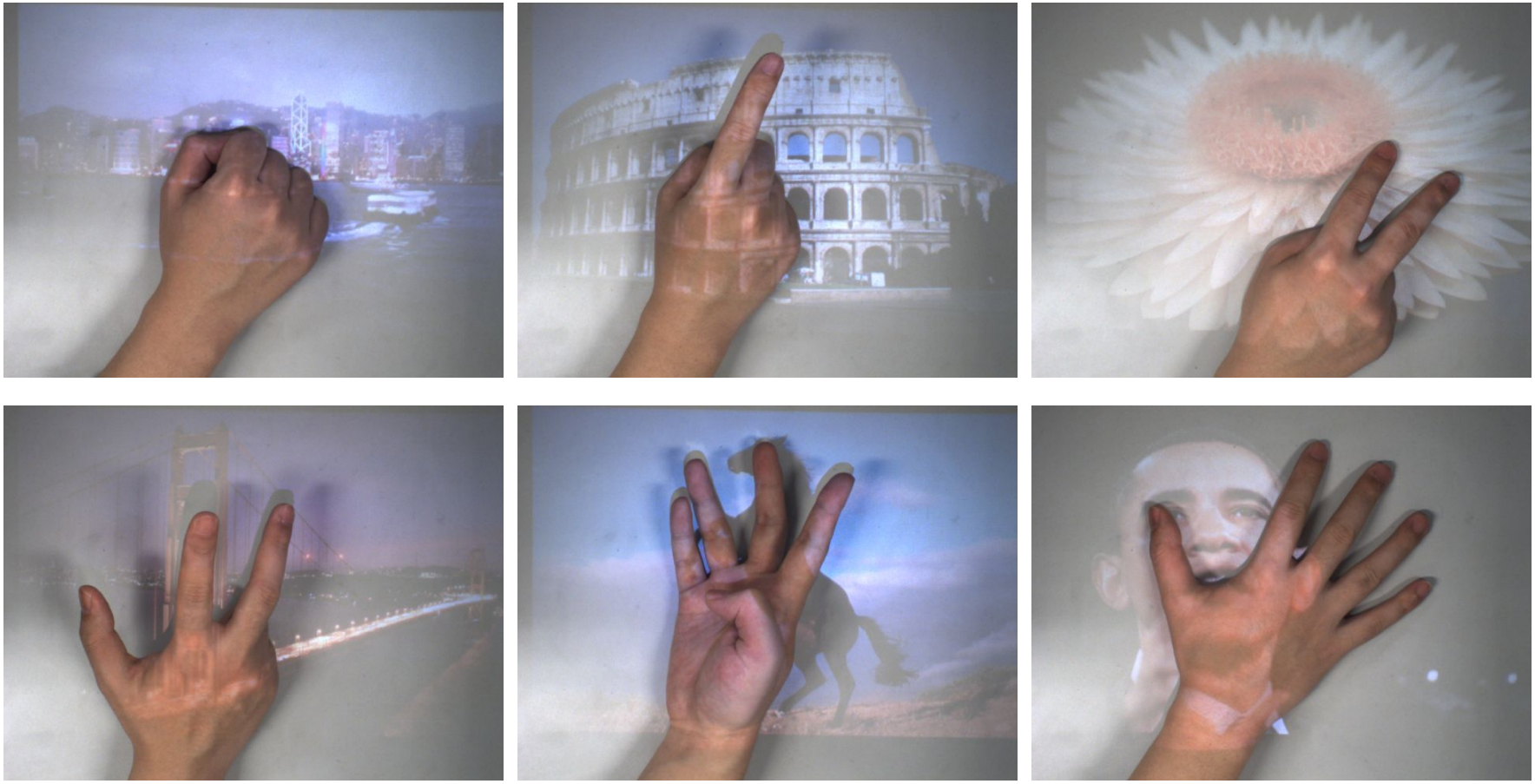
  - *The **average salient value** of the pixels in the partition*
  - *The **number** of the neighbor partitions and the **average salient value** of neighbor partitions*
  - *The **area** of the partition*
  - *Whether the partition is on the **image boundaries***

$$\begin{cases} \beta = \frac{1}{2}, \alpha = \gamma = \frac{1}{4}, & \text{when N} = 1 \\ \alpha = \frac{1}{2}, \beta = \gamma = \frac{1}{4}, & otherwise \end{cases}$$

Precise Segmentation by Fusing



Experiments – *Data Collection*

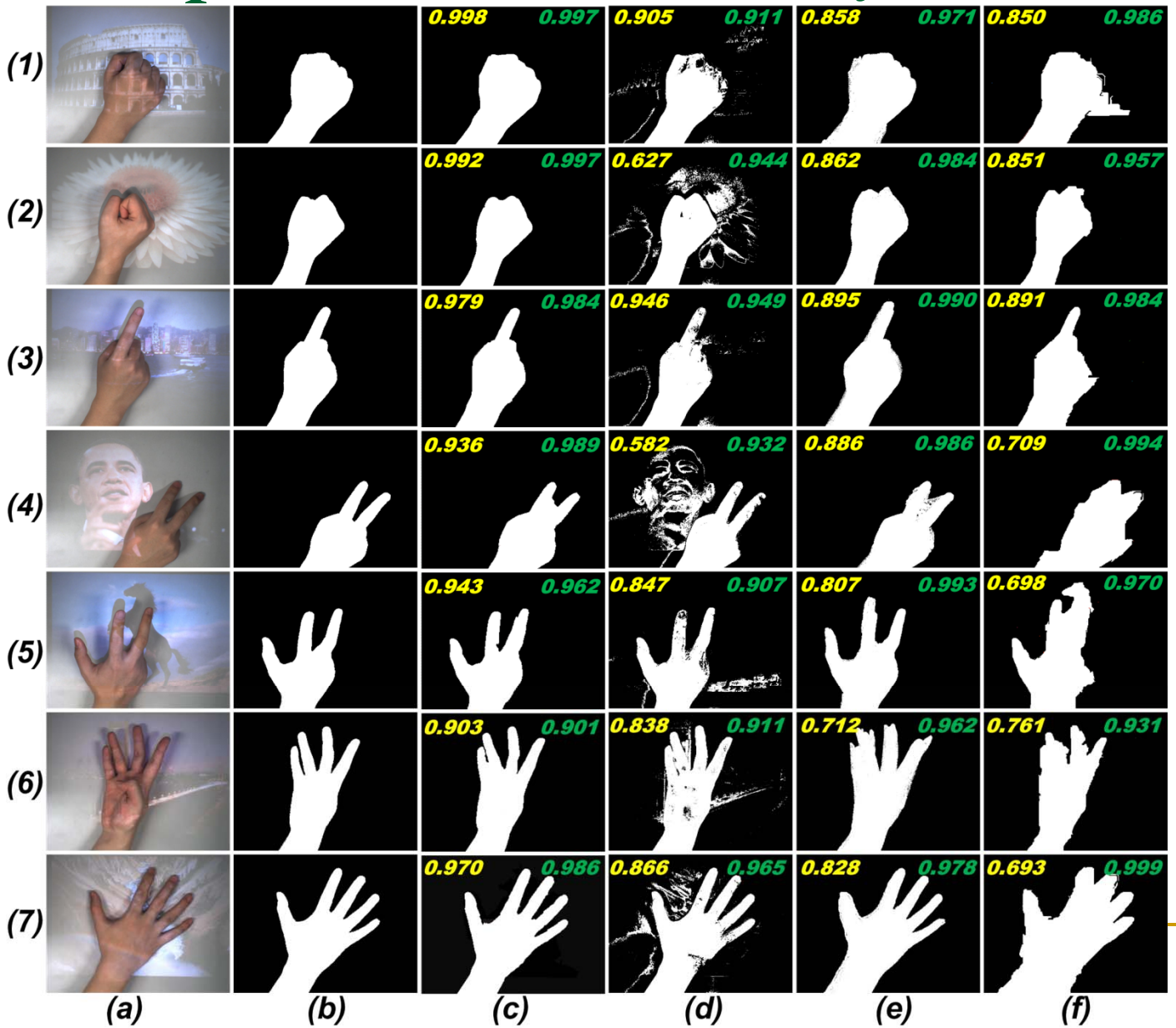


Experiments – *Accuracy Evaluation*

- **Comparison with related methods**
  - *The classic approach of **statistical color model-based** method (most cited in literature)*
  - *The **background subtraction** method (most precise)*
  - *The **graph based** method (most recent)*
- **Evaluation Criterion**
  - *Precision:* $p = \frac{N_C}{N_R}$
  - *Recall:* $r = \frac{N_C}{N_G}$
  - *F-beta score:* $F_\beta = \frac{(1+\beta^2)pr}{\beta^2 p + r}$

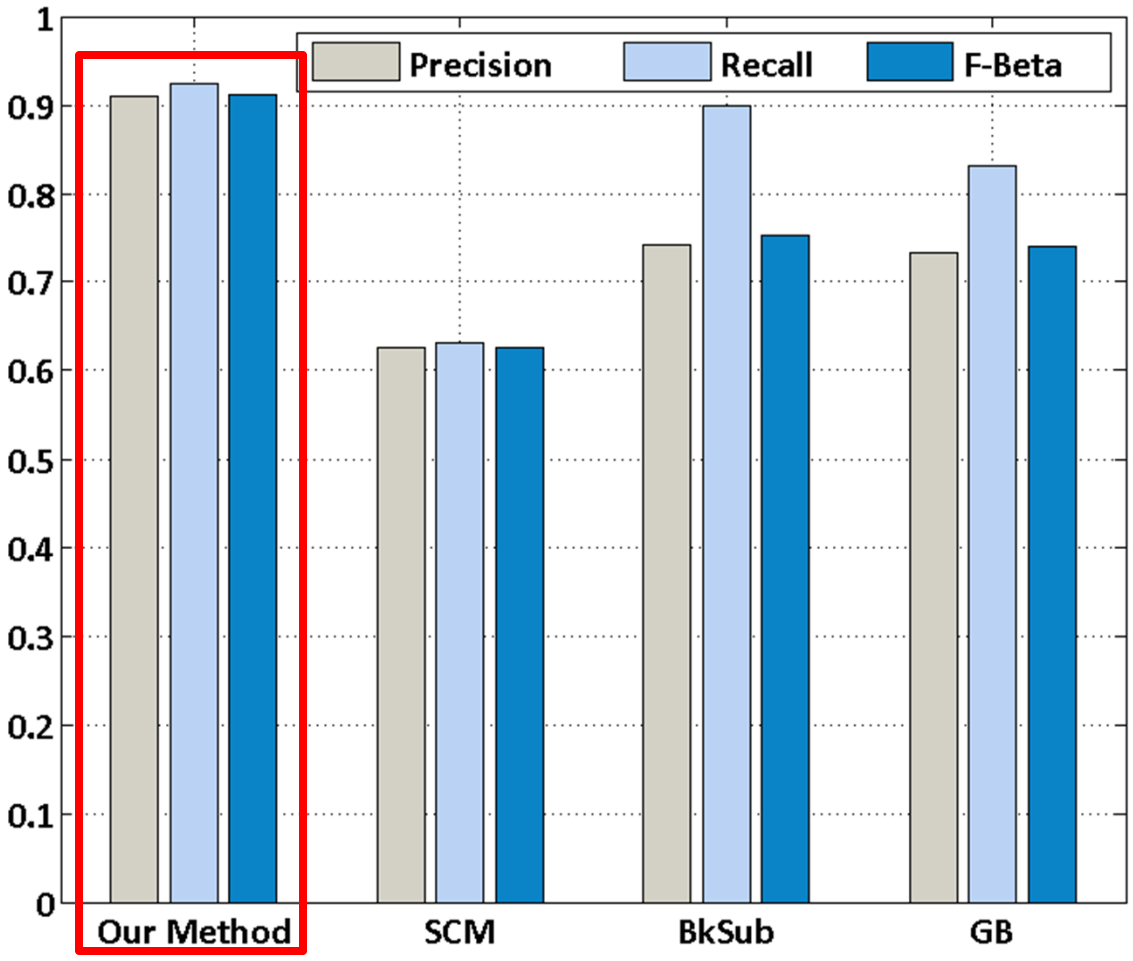
N_C, N_R, N_G *are the number of **correct segmented** pixels, **all segmented** pixels and **ground-truth** pixels respectively.*

Experiments – *Accuracy Evaluation*



(a) Original Image
(b) Ground-truth
(c) Our Method
(d) SCM
(e) BkSub
(f) GB

Experiments – *Accuracy Evaluation*



Experiments – *Efficiency Evaluation*

Method	Ours	SCM	BkSub	GB
Time (ms/frame)	*29.6*	*10.9*	*2.3*	*115.2*

Conclusion and Future Works

- **A novel *coarse-to-fine* approach for hand segmentation in projector-camera system, which puts together *contrast saliency* and *region discontinuity* information through a *confidence function*.**

- **Future Works**
  - *Improve the formulation of confidence function*
  - *Reduce algorithm complexity*

THANK YOU!!

If you have any questions, please contact

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