



GRAPH-BASED RGB-D IMAGE SEGMENTATION USING COLOR-DIRECTIONAL-REGION MERGING

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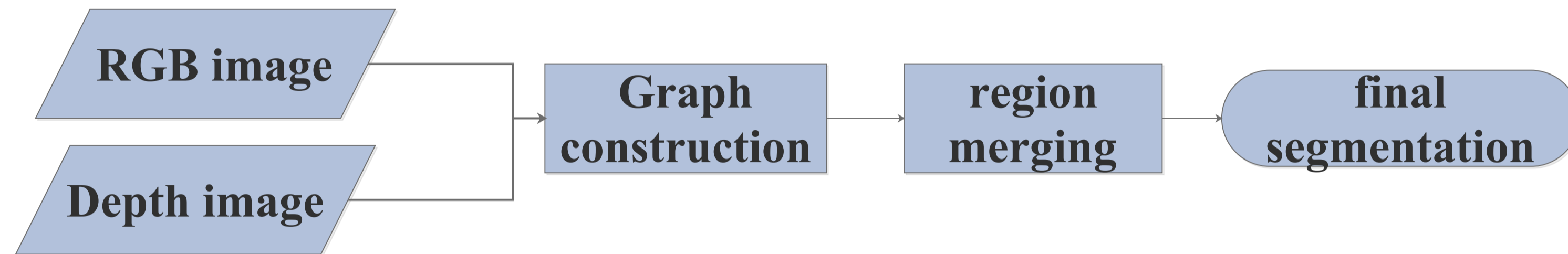
1. Motivation

1) Image segmentation is an important task in image and video processing and has many applications.

2) Based on the RGB-D image data, the quality of segmenting scenes can be improved via exploiting color and depth information simultaneously.

So, we proposed a novel graph-based RGB-D image segmentation algorithm for indoor scene.

2. Outline of the method



3. The Proposed Method

• Dissimilarity of two adjacent pixels

The dissimilarity of two adjacent pixels, p_i and p_j , consists of two terms, color- and normal-variation between these two pixels, and they are linearly combined using adaptive data-driven weight. The dissimilarity of p_i and p_j is given by

$$k(p_i, p_j) = \frac{w(p_i, p_j) \cdot c(p_i, p_j) + v(p_i, p_j) \cdot f(p_i, p_j)}{w(p_i, p_j) + v(p_i, p_j)}$$

where $c(p_i, p_j)$ and $f(p_i, p_j)$ are color- and normal-variation between p_i and p_j , respectively. $w(p_i, p_j)$ and $v(p_i, p_j)$ are data-driven weight calculated through using color information of pixels around these two pixels.

The color variation $c(p_i, p_j)$ is from [1]

$$c(p_i, p_j) = \sqrt{r(p_i, p_j)^2 + g(p_i, p_j)^2 + b(p_i, p_j)^2}$$

and the normal variation is defined as

$$f(p_i, p_j) = 1 - \cos(\langle \vec{n}_{p_i}, \vec{n}_{p_j} \rangle)$$

where \vec{n}_{p_i} and \vec{n}_{p_j} denote the normal vectors at pixel p_i and p_j , respectively.

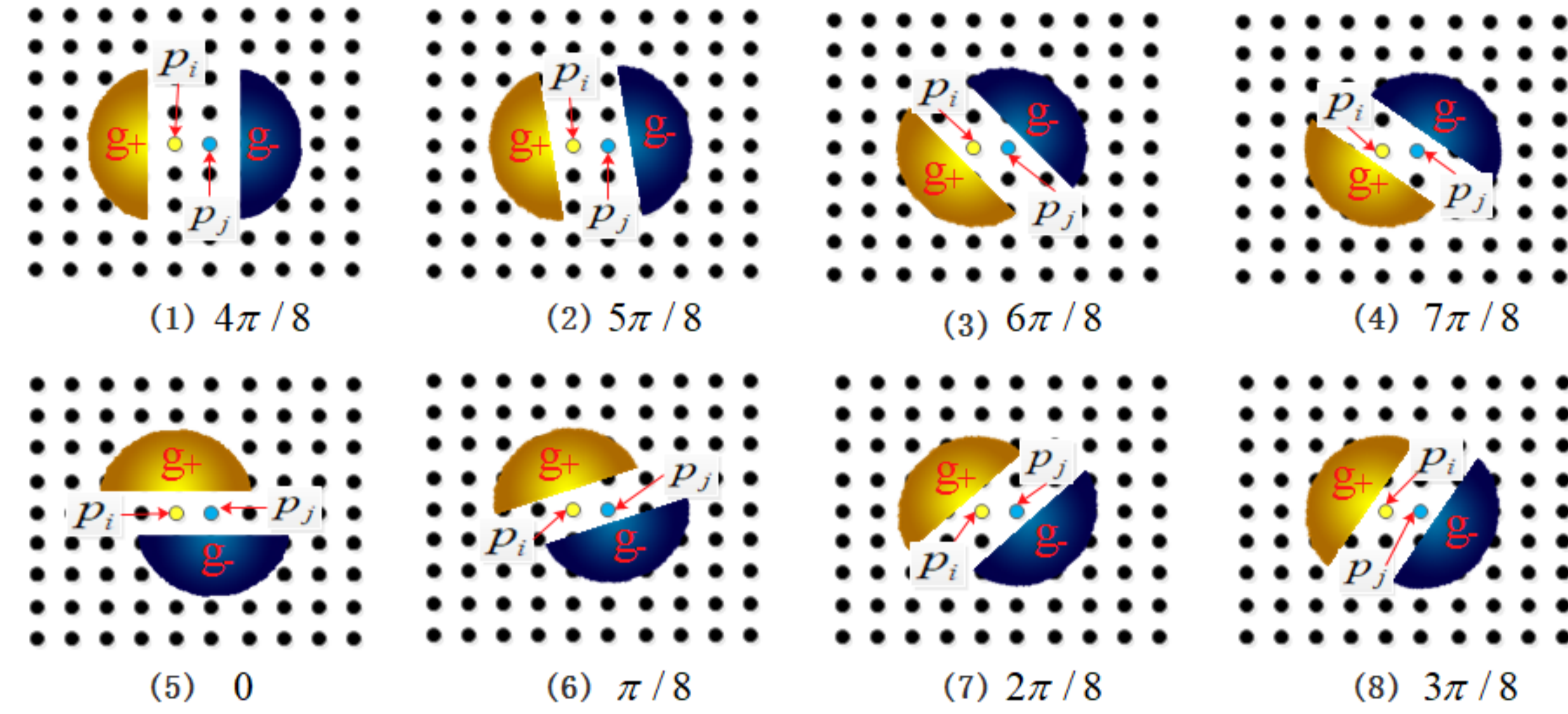


Fig. 1 Bi-semi-Gaussian functions.

The weight $w(p_i, p_j)$ and $v(p_i, p_j)$ are defined as

$$w(p_i, p_j) = \max_{\theta} \{ \nabla(p_i, p_j; \theta) \}$$

$$v(p_i, p_j) = \exp(w(p_i, p_j) - \alpha)$$

and $\nabla(p_i, p_j; \theta)$ is defined as

$$\nabla(p_i, p_j; \theta) = |m_{g_+}(p_i, \theta) - m_{g_-}(p_j, \theta)|$$

α is a constant, the bi-semi-circle regions at direction θ , as shown in Fig. 1.

• Region merging

Inspired by [1], the proposed criterion consists of three aspects, as shown in Fig. 2.

The termination threshold value is defined as:

$$T(\Omega_i; \Omega_j) = [\varepsilon - \varphi(\Omega_i, \Omega_j)] / N_i$$

$$T(\Omega_j; \Omega_i) = [\varepsilon - \varphi(\Omega_i, \Omega_j)] / N_j$$

where ε is a constant; N_i and N_j are the number of pixels in the regions, respectively. $\varphi(\Omega_i, \Omega_j)$ is defined as

$$\varphi(\Omega_i, \Omega_j) = 1 - \cos(\langle \vec{n}_{\Omega_i}, \vec{n}_{\Omega_j} \rangle)$$

where \vec{n}_{Ω_i} and \vec{n}_{Ω_j} are average normal in regions Ω_i and Ω_j , respectively.

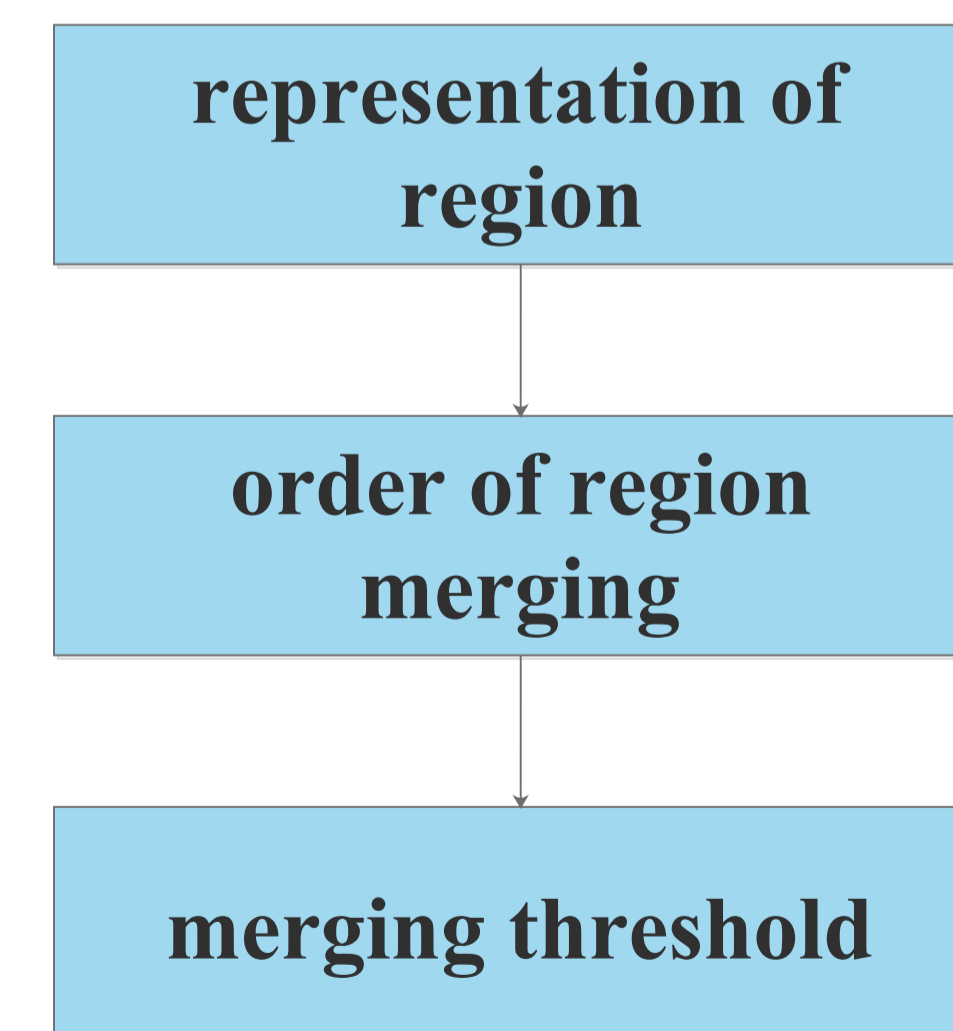


Fig. 2 Three aspects

REFERENCES

- [1] P.F. Felzenszwalb, and D. P. Huttenlocher, "Efficient graph-based image segmentation", *International Journal of Computer Vision*, vol. 59, no. 2, pp. 167-181, 2004.
[2] S. Song, S. P. Lichtenberg, and J. Xiao, "Sun rgb-d: A rgb-d scene understanding benchmark suite," in *2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2015, pp. 567-576.

4. Experiments

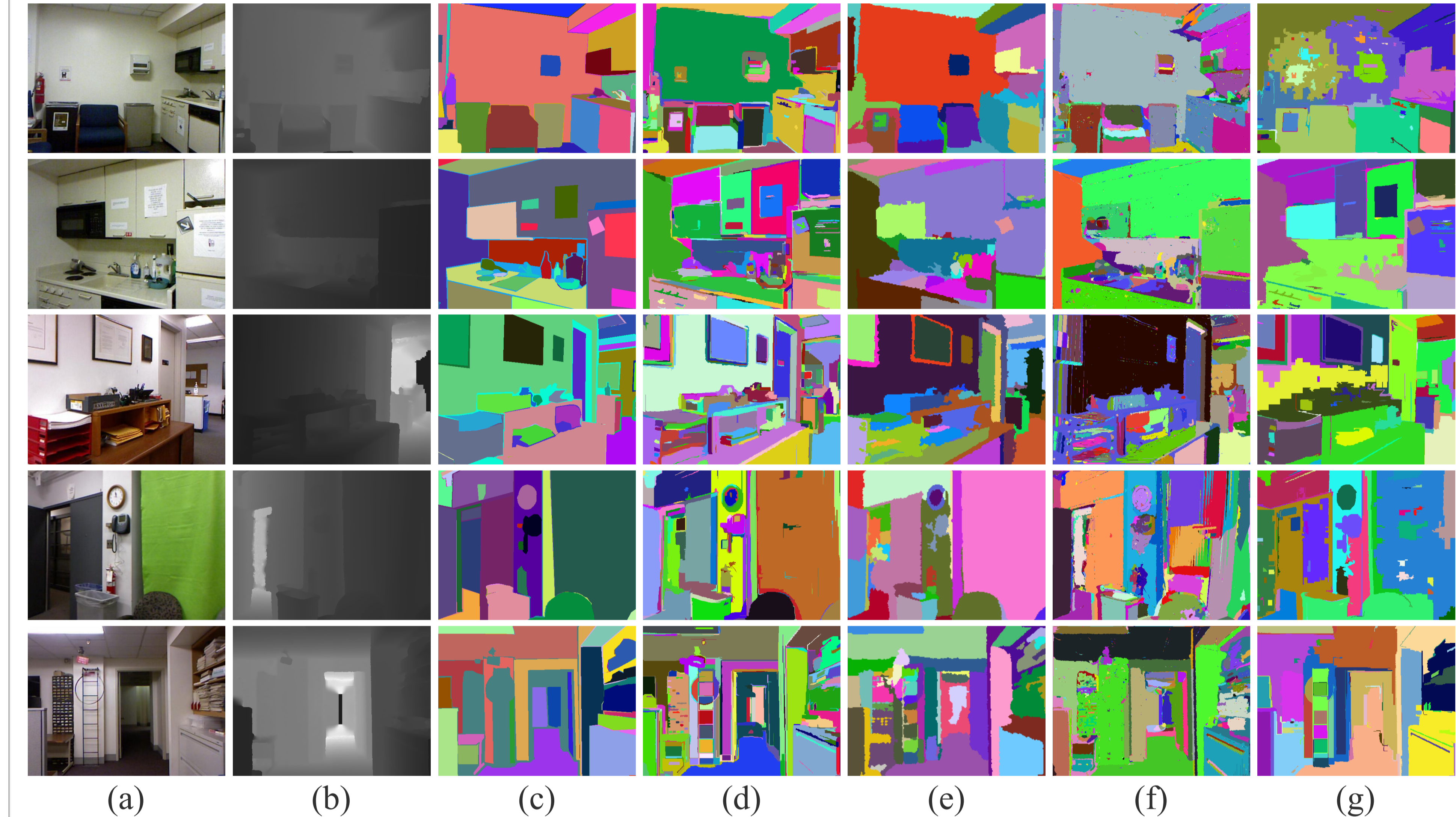


Fig. 3 Segmentation results on NYUv2 dataset. (a)Original color image, (b)depth image, (c)ground Truth, (d)our method, (e)JCS-D-RM, (f)PIS, and (g)GB-RGBD.

Table 1. Comparing with the state-of-the-art methods.

	GTRC			PRI		VI		P	R	BFM
	ODS	OIS	Best	ODS	OIS	ODS	OIS			
PIS	0.43	-	-	0.88	-	3.16	-	0.37	0.69	0.48
GB-RGBD	0.44	0.49	0.56	0.87	0.89	2.46	2.34	0.40	0.60	0.48
JCS-D-RM	0.55	-	-	0.91	-	2.12	-	0.56	0.43	0.49
OUR METHOD	0.50	0.55	0.61	0.90	0.91	2.42	2.25	0.38	0.76	0.51

ODS: a universal fixed scale

OIS: a fixed scale per image

Best: from any level of the hierarchy or collection Ground truth: extracted from [2]

Table 2. Comparing with the proposed and JCS-D method.

	GTRC	PRI	VI	BFM
JCS-D	0.46	0.87	2.68	0.46
OUR METHOD	0.50	0.90	2.42	0.51

the website of project: https://github.com/PanXiongAdam/Graph_RGBD