



Saliencet
Object
Detection

Introduction
Color Space
Priors

Saliencet Object Detection

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What is saliency?

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Visual saliency is the ability of a vision system(human or machine) to select a certain subset of visual information for future processing¹ .



E.g. The car should have high saliency.

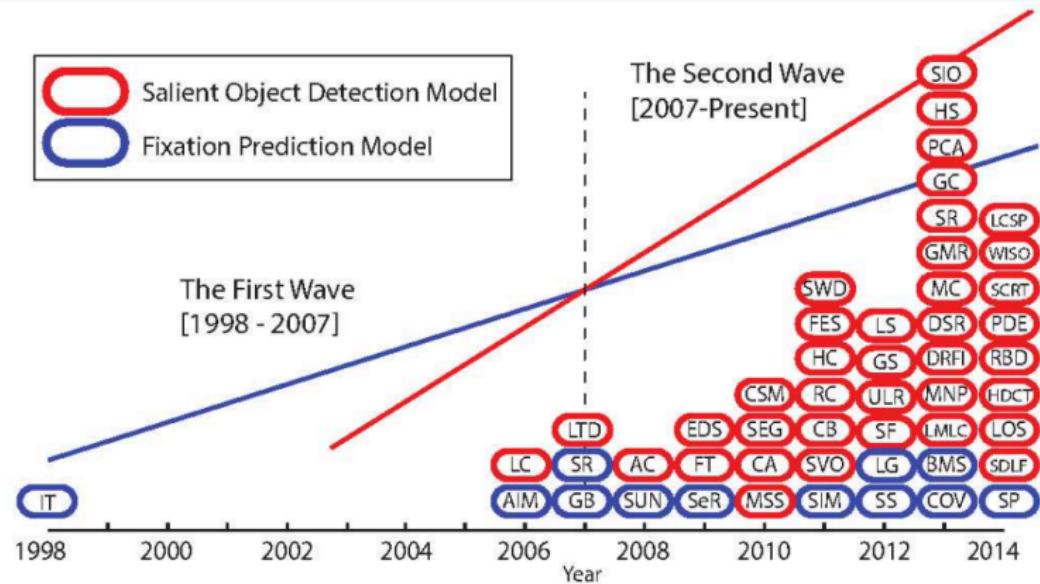
¹Borji, Ali and Sihite, Dicky N and Itti, Laurent, “Salient object detection: A benchmark,” in ECCV, 2012, pp. 414–429.



Two Waves

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Fixation Prediction

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Fixation prediction models are constructed originally to understand human visual attention and eye movement prediction.





Representative Method

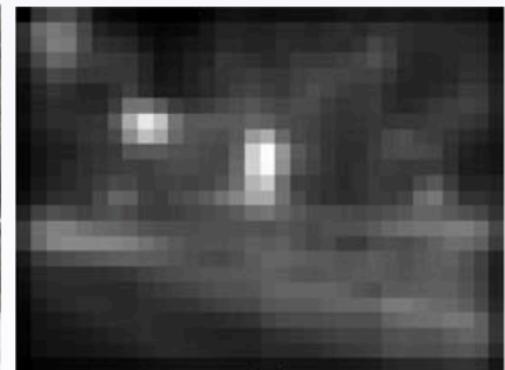
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- A model of saliency-based visual attention for rapid scene analysis. PAMI 1998, Itti et al.





Salient Object Detection

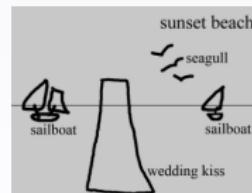
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The emergence of salient object detection models is driven by the requirement of saliency-based applications.



Content aware resizing



Object manipulation



Image montage

Image collage



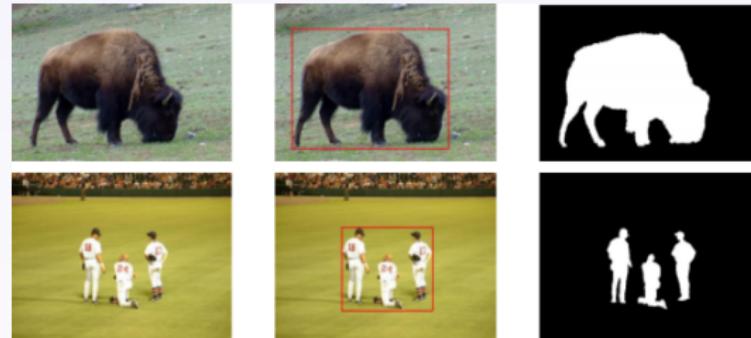
Representative Methods

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- Learning to detect a salient object. CVPR 2007, Tie Liu et al.
- Frequency-tuned salient region detection. CVPR 2009, Achanta et al.



Differences and Commons

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- Differences
 - Evaluation and Datasets
 - Aims
 - Accuracy requirement
- Commons
 - Both of them generate similar saliency maps



Related Topics

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- Image Segmentation
- Object Proposal Generation



Salient Object Detection

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■ *Block-based* vs. *Region-based analysis*

Blocks are usually adopted by many early approaches, while regions are increasingly popular with the development of superpixel algorithms.

■ *Intrinsic cues* vs. *Extrinsic cues*



Salient Object Detection

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Uniqueness

Local Contrast Global Contrast Multi-scale Contrast

Salient object detection is widely defined as capturing the uniqueness, distinctiveness, or rarity of a scene.

- Pixel-based
- Block-based
- Region-based



Definition

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- *Color* is the visual perceptual property corresponding in humans to the categories called red, blue, yellow and others.
- *Color Space* is defined to identify colors numerically by their coordinates.

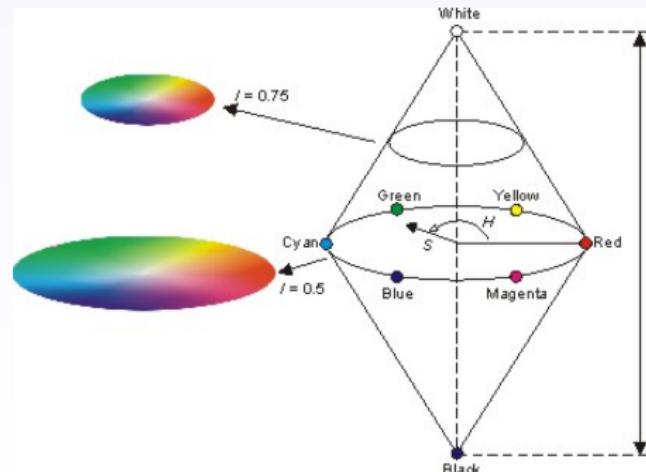


Three Elements of Color

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- Hue: What we think as “color”—yellow, orange, cyan and magenta are examples of different hues
- Saturation: Saturation refers to the relative purity or the amount of white light mixed with a hue
- Intensity





Device-independent spaces

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- CIE XYZ
- CIELAB
- CIELUV

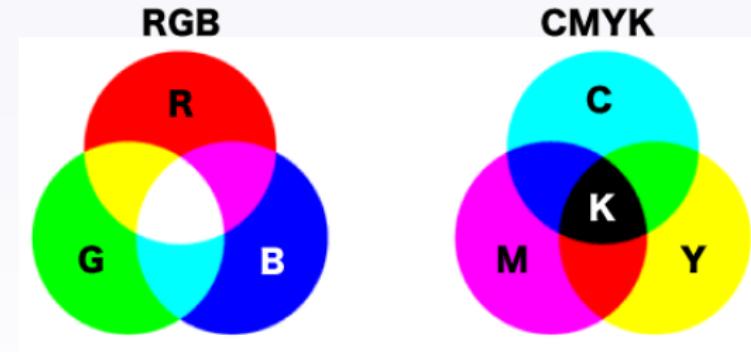


Device-dependent spaces

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■ RGB、CMYK





Transformation

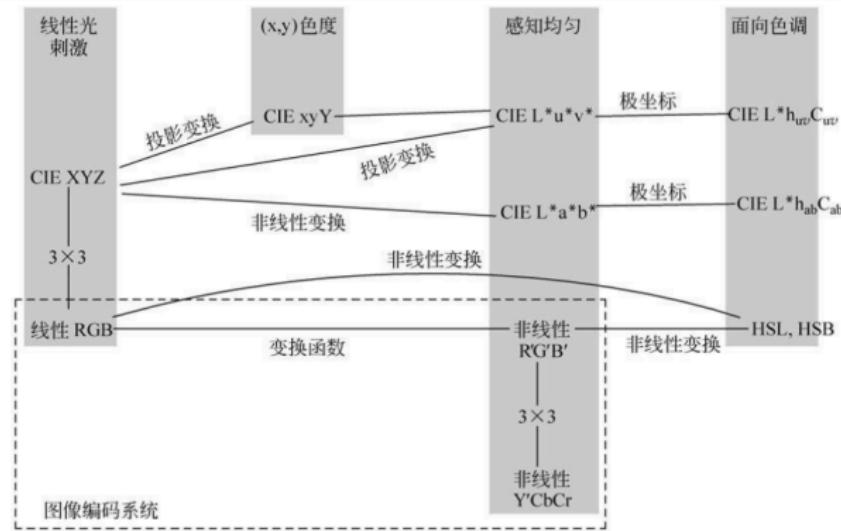
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Almost all the color spaces can be transformed from RGB color space.





Priors

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- Center Prior/Location Prior
- Backgroundness Prior
- Boundary Connectivity Prior
- Color Prior
- Objectness Prior
- Smoothness Prior



Center Prior/Location Prior

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Objects near the image center are more attractive to people.²

This prior can be simply and effectively modeled as a Gaussian map.



$$S_D(\mathbf{x}) = \exp\left(-\frac{||\mathbf{x} - \mathbf{c}||_2^2}{\sigma_D^2}\right) \quad (1)$$

²Zhang, Lin and Gu, Zhongyi and Li, Hongyu, "SDSP: A novel saliency detection method by combining simple priors", in ICIP, 2013.



Center Prior/Location Prior

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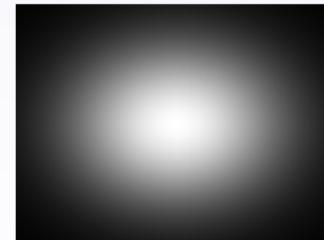
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The salient object in an image is most probably placed near the center of the image.³

Gaussian falloff weight:

$$w_i^{(n)} = \exp(-9(dx_i^{(n)})^2/w^2 - 9(dy_i^{(n)})^2/h^2) \quad (2)$$



³Jiang, Huaizu and Wang, Jingdong, "Automatic salient object segmentation based on context and shape prior", in BMVC, 2011



Center Prior/Location Prior

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Assigning higher saliency to the image elements near the image center becomes invalid when the objects are placed far off the image center⁴.

- Compute a convex hull enclosing interesting points to estimate the location of salient region.
- Use the centroid of the convex hull as the center to get the convex-hull-based center prior map.



⁴Yang, Chuan and Zhang, Lihe and Lu, Huchuan, "Graph-regularized saliency detection with convex-hull-based center prior", in Signal Processing Letters, IEEE, 2013



Backgroundness Prior

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Backgroundness prior is more general than center prior because salient objects can be placed off the center, but they seldom touch the image boundary.⁵

- Assuming that a narrow border of the image is background region, regional saliency can be computed as the contrast versus “background”.

⁵Wei, Yichen and Wen, Fang and Zhu, Wangjiang, “Geodesic saliency using background priors”, in ECCV, 2012.



Boundary Connectivity Prior

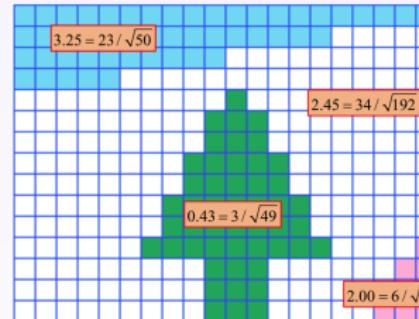
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Object regions are much less connected to image boundaries than background ones.⁶



Boundary connectivity is defined to quantify how heavily a region R is connected to the image boundaries.

$$BndCon(R) = \frac{|\{p | p \in R, p \in Bnd\}|}{\sqrt{|\{p | p \in R\}|}} \quad (3)$$

⁶Zhu, Wangjiang and Liang, Shuang, “Saliency optimization from robust background detection”, in CVPR, 2014.



Color Prior

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Warm colors, such as red and yellow, are more pronounced to the human visual system than cold colors, such as green and blue.⁷

$$f_{an}(\mathbf{x}) = \frac{f_a(x) - mina}{maxa - mina}, f_{bn}(\mathbf{x}) = \frac{f_b(x) - minb}{maxb - minb} \quad (4)$$

$$S_c(\mathbf{x}) = 1 - exp\left(-\frac{f_{an}^2(\mathbf{x}) + f_{bn}^2(\mathbf{x})}{\sigma_c^2}\right) \quad (5)$$

- a^* -channel represents green-red information
- b^* -channel represents blue-yellow information

⁷Zhang, Lin and Gu, Zhongyi and Li, Hongyu, “SDSP: A novel saliency detection method by combining simple priors”, in ICIP, 2013.



Objectness Prior

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Objectness is defined as the probability of there being a complete object in a local window centered on each pixel.⁸

- Randomly sample N windows over the image
- Assign each window w a probability score $P(w)$ to indicate its objectness
- Sum all the probability scores in windows that contains pixel x

$$O_p(x) = \sum_{w \in W \text{ and } x \in w} P(W_x) \quad (6)$$

⁸Jiang, Peng and Ling, Haibin, “Salient region detection by ufo: uniqueness, focusness and objectness”, in ICCV, 2013



Smoothness Prior

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Smoothness constraint is often encoded by adding a pair-wise potential to the energy function which encourages neighboring pixels in the image to take the same label.⁹

$$w_{ij} = \exp\left(-\frac{\|c_i - c_j\|}{2\sigma_w^2}\right) \quad (7)$$

$$E(S) = \sum_i (S(i) - S_i n(i))^2 + \lambda \sum_{i,j} w_{ij} (S(i) - S(j))^2 \quad (8)$$

⁹Yang, Chuan and Zhang, Lihe and Lu, Huchuan, "Graph-regularized saliency detection with convex-hull-based center prior", in Signal Processing Letters, IEEE, 2013.