# Absent Color Indexing and Its Application to Pattern Search

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**Abstract**

Conventional color histogram-based methods are not sensitive to search similar objects. We propose a novel approach for robust pattern search for based on Absent Color Indexing (ABC). First of all, ABC method generates two-dimensional color histogram via CIE Lab color space. Then, the threshold $h_T$ is proposed to divide color histogram into an apparent and absent color histogram. To enhance performance on absent colors, we invert absent color histograms. Finally, we calculate similarity by intersection. Experimental results show the ABC method more robustness than conventional color histogram-based methods.

## 1 Introduction

Color histograms have been utilized for a long time as a representation of key features. The conventional color histogram methods focus on the similarity with high-frequency color bins. Therefore, it ignores the low-frequency feature from the color histogram. With this problem, we propose a novel approach based on absent color indexing (ABC) for pattern search in CIE Lab color space.

## 2 Absent color indexing

CIE Lab is a color space closer to human vision. We can perform nonlinear color space transformation from RGB color space to CIE Lab color space by pixel-wise calculation.

### 2.1 Histogram decomposition

Two two-dimensional color histograms $H'$ and $G'$ obtain from two images as the examples. The total $N$ pixels in each image are classified into the color histograms of $I$ by $J$ bins in ab color coordinate system. Therefore, we can use $H' = \{h'_{ij}\}_{(i,j)=(1,1),\cdots,(I,J)}$ to represent the two-dimensional color histogram.

Normalization can effectively represent relative frequencies $H = \{h_{ij}\} = \left\{\frac{h'_{ij}}{N}\right\}_{(i,j)=(1,1),\cdots,(I,J)}$, where $H$ is the color histogram $H'$ after normalization.

A threshold $h_T$ is introduced for the proposed decomposition of the color histogram into the two separated color histograms.

The original histogram $H$ is decomposed into ${}^{AP}H + {}^{AB}H$ as

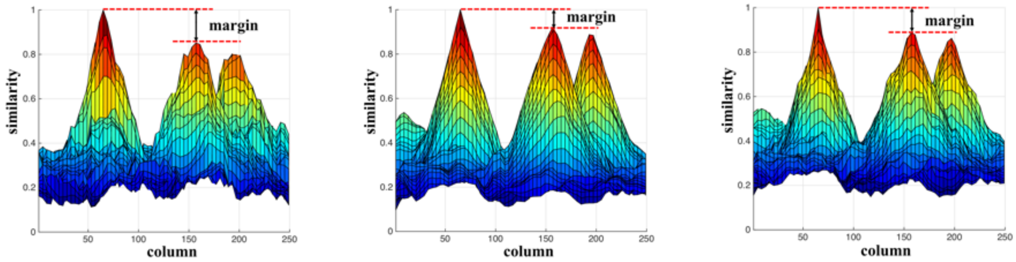
$$ {}^{AP}H = \left\{ {}^{AP}h_{ij} \middle| {}^{AP}h_{ij} = h_{ij} > h_T \right\} \quad (1)$$

$$ {}^{AB}H = \left\{ {}^{AB}h_{ij} \middle| {}^{AB}h_{ij} = h_{ij} \le h_T \right\} \quad (2)$$

where ${}^{AP}H$ represents apparent color histogram, ${}^{AB}H$ is an absent color histogram.

Complementation or inversion of ${}^{AB}H$ follows the decomposition. The frequencies in the inverted histogram ${}^{AB}\overline{H} = \left\{ {}^{AB}\overline{h}_{ij} \right\}$ is defined. If ${}^{AB}h_{ij} > 0$ as follows:

$$ {}^{AB}\overline{h}_{ij} = h_T - {}^{AB}h_{ij} \quad (3)$$




(a) ABC (b) CI (c) CCH

**Fig. 2.** Projected profiles of similarity (No noise $\sigma^2 = 0,\ h_T = 0.01$)

Otherwise we have additional definitions to complete the inversion of the histogram as follows: if ${}^{AB}h_{ij} = 0$ and ${}^{AP}h_{ij} > 0$ then ${}^{AB}\bar{h}_{ij} = 0$ and if ${}^{AB}h_{ij} = 0$ and ${}^{AP}h_{ij} = 0$ and ${}^{AB}g_{ij} > 0$ then ${}^{AB}\bar{h}_{ij} = h_T$.

The second rule shows that in this image the color should be handled as one of the apparent colors, while the last rule has a particular condition on the component ${}^{AB}\bar{h}_{ij}$, for which ${}^{AB}g_{ij} > 0$, i.e. ${}^{AB}\bar{h}_{ij}$ can have the part of counter to compare with in evaluating absent colors as enhanced features.

At the last step, it is necessary to normalize both ${}^{AB}H$ and ${}^{AB}\bar{H}$ into $H^{AP} = \{h_{ij}^{AP}\}$ and $H^{AB} = \{h_{ij}^{AB}\}$ for satisfying the condition that all the components should be summed up to 1.

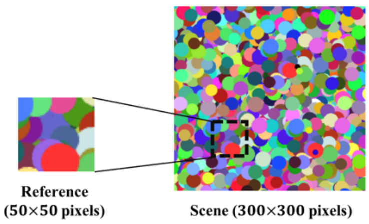



**Fig. 1.** Mondrian random pattern.

## 3 Experiments

The references in Fig. 1 are searched back in the scene itself or similar scene with noises through scanning all of the positions, and then the partial or overall profiles can be used for evaluating basic performances of these methods.

### 3.1 Basic performance of ABC

Margin refers to the difference in similarity between the best matching position and a second best one. Large margin means a strong distinguish ability for handling similarity objects interference. Fig. 2 shows the profiles of intersection projected onto the horizontal axis for three methods. The margin of ABC is larger than another two methods. Fig. 3 shows the matching result in clutter scene.


**Fig. 3.** Search in clutter scene.

## 4 Conclusions

We presented a novel method named Absent Color Indexing for highly reliable pattern search. The proposed method pay attention to test not only apparent colors but also absent colors that have low frequencies in the histogram. In many experiments, we could see ABC has a good performance for discrimination under some severe conditions.

## Reference

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