Enhancing Visual Dominance by Semantics-Preserving Image Recomposition

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What's really important is to simplify. The work of most photographers would be improved immensely if they could do one thing: get rid of the extraneous. If you strive for simplicity, you are more likely to reach the viewer.

William Albert Allard

INTRODUCTION

It is essential to **make the subjects of interest dominant** so that the viewers' attention is directed to what the photographer wants them to see. However, no research has attempted to **make the subjects more dominant by directly changing the subject-background spatial relationship.**

OBJECTIVE

To **geometrically transform the immediate background** of a photo subject, such that the **subject become more dominant** – simulating an effect analogous to change of camera viewpoint.

(left) Input image and its saliency map. (right) Recomposed image and its saliency map.

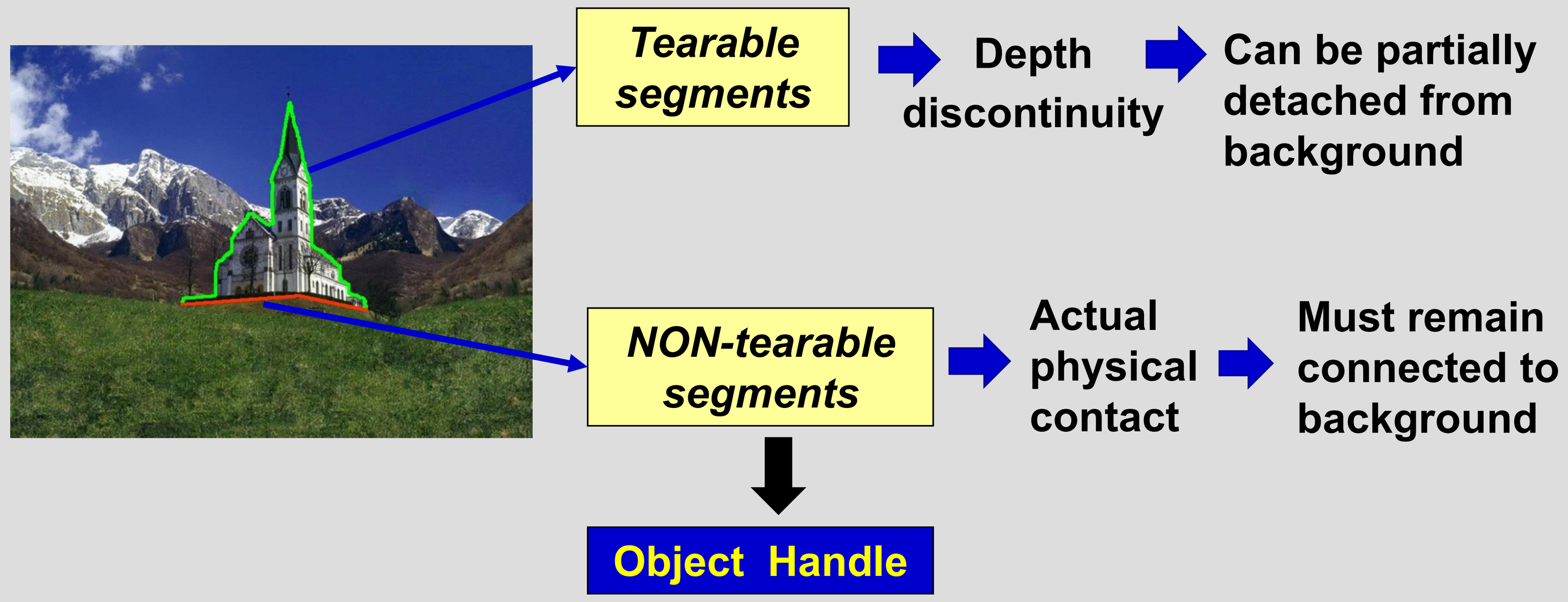
MAKING THE SUBJECT DOMINANT

Two important components:

- An **image operator** to transform the input image.
- A **subject dominance measure**, to guide the image operator to produce an output image with enhanced subject dominance.

Image Operator

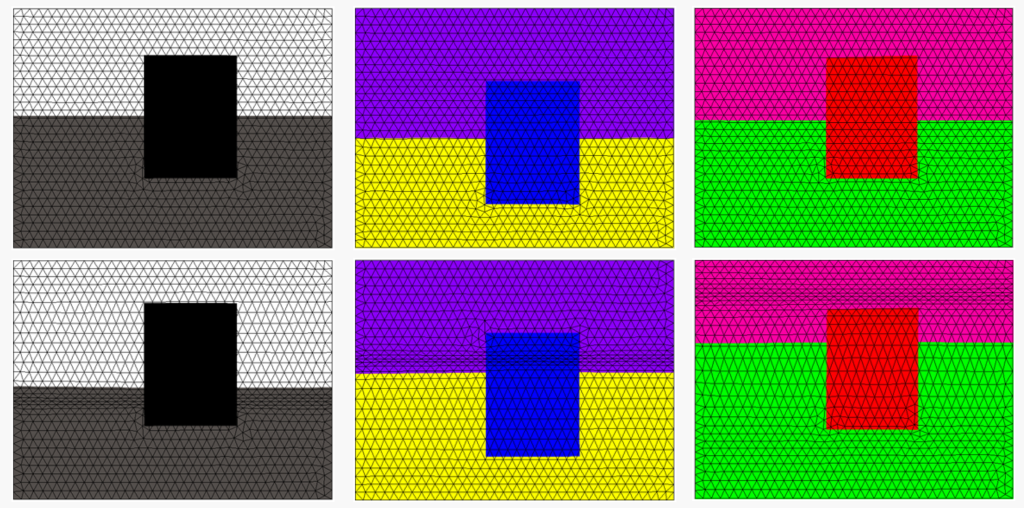
Tearable image warping (Wong and Low, 2012) – an innovative image warping approach that divides an object boundary into tearable and non-tearable segments.



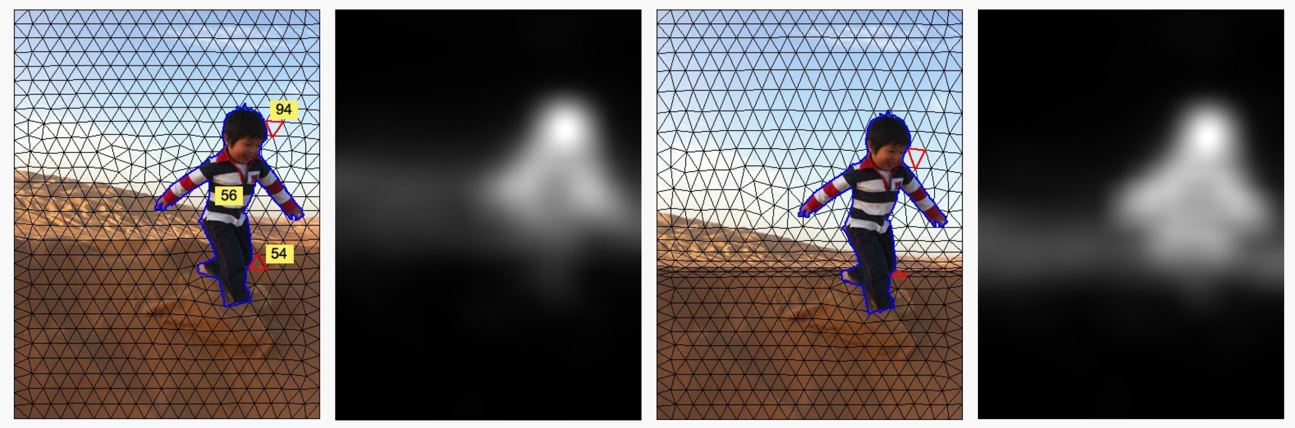
Object handle: Polyline drawn by user to specify the non-tearable segments.

Subject Dominance Measure

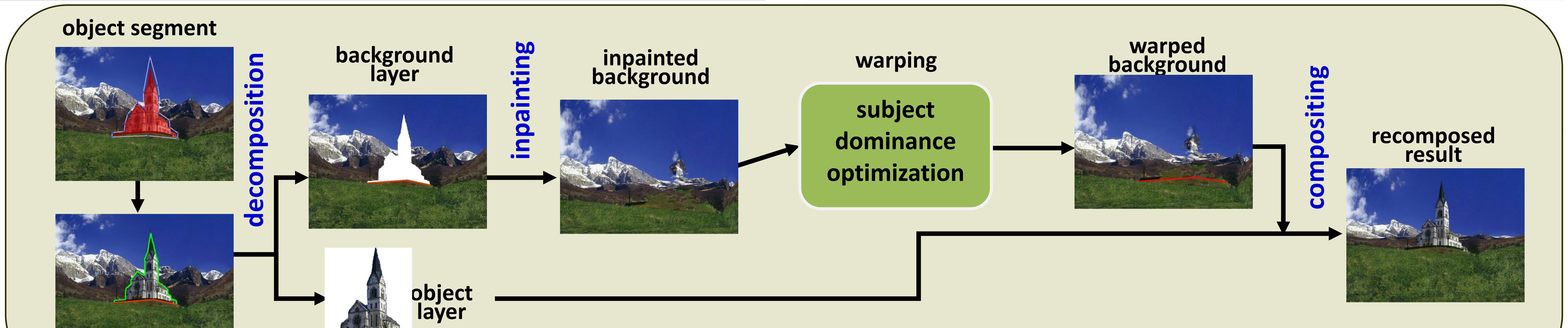
We formulate the subject dominance measure based on a simplified adaptation of the Itti-Koch biological-inspired visual attention model (1998). We treat the **photo subject as the center** and its immediate **background as the surround**, and measure subject dominance by computing the **center-surround differences** of two low-level features—**intensity** and **color**—between the subject and its background (represented as a triangle mesh).



(top) Synthetic input images that possess luminance and color contrast.
(bottom) Results of algorithm show increased visual dominance of the rectangle.



(left) Input image with triangle mesh and its saliency map. Yellow rectangles show the average luminance values in the subject and red triangles.
(right) Recomposed image with triangle mesh and its saliency map.



ALGORITHM OVERVIEW

ALGORITHM

Our algorithm is performed in three main steps:
1) **decomposition**
2) **warping & subject dominance optimization**
3) **image compositing**

Warping Energy

The warping energy consists of a **scale transformation error** (Jin et al. 2010),

$$E_w = \sum_{t \in T} A_t(|J_t - G_t|_F^2) \quad (1)$$

and a **smoothness error**,

$$E_S = \sum_{\substack{s,t \in T \\ s,t \text{ are adjacent}}} A_{st}(|G_t - G_s|_F^2) \quad (2)$$

where $A_{st} = (A_s + A_t)/2$.

Results: **Subject dominance energy only.**

Subject Dominance Energy

To maximize the luminance and color contrast in the Lab color space, we minimize the *subject dominance energy* E_D, which is defined as

$$E_D = E_L + E_C \quad (3)$$

where E_L is the **luminance contrast energy**:

$$E_L = \sum_{o \in O} \sum_{t \in T_O} s_t(|L_t' - L_o| - \psi_L) \quad (4)$$

and E_C is the **color contrast energy**:

$$E_C = \sum_{o \in O} \sum_{t \in T_O} s_t\left(\sqrt{(a_t' - a_o)^2 + (b_t' - b_o)^2} - \psi_{ab}\right). \quad (5)$$

The parameters ψ_L and ψ_{ab} indicate **the target level of dominance**, where

$$\psi_L = \left(\frac{1}{|T_O|} \sum_{t \in T_O} |L_t - L_o|\right) + \mu \quad (6)$$

and

$$\psi_{ab} = \left(\frac{1}{|T_O|} \sum_{t \in T_O} \sqrt{(a_t - a_o)^2 + (b_t - b_o)^2}\right) + \mu \quad (7)$$

We obtain the following **value for μ**, using a systematic graph fitting approach (see our paper):

$$\mu = \left(\frac{S(F)B(F)}{\tau} - \frac{B(F)}{18 * S(F)}\right) \quad (8)$$

For luminance (Eq 6), $\tau = 9$ and for color (Eq 7), $\tau = 6$.

Total Energy

To recompose an image, we combine the subject dominance energy with the warping energy:

$$E = \alpha E_W + \beta E_S + \gamma E_D \quad (9)$$

We set $\alpha = 1$, $\beta = 0.5$ and $\gamma = 1$.

EXPERIMENTAL RESULTS

- **Online user experiment:** For 30 pairs of images, participants were asked to choose between the input images and our results, for the one in which the subject stands out more against the background.
- 40 participants aged between 22 and 46.
- **OUTCOME:** For **83%** of the image pairs, our results were chosen.

CONCLUSION

We demonstrated a successful **semi-automatic recomposition** method that employs tearable mage warping as the image operator and uses a simplified center-surround contrast measure to guide the warping to **enhance the visual dominance of the photo subjects**. Our results and user experiment have shown the effectiveness. Our method can be extended with **more aesthetics features** as shown in the results below.

Results: **Subject dominance + rules-of-thirds + visual balance energies.**

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