Preserving the aesthetics during non-fixed aspect ratio scaling of the digital border

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ABSTRACT
To enhance the visual effect of a photo, various digital borders or frames are provided for photo decoration at photo sharing websites. Even though multiple versions of the same border design may be prepared manually for several "standard" page or photo sizes, difficulty arises when the user's page or photo sizes are not one of the standards. Forcing a photo into the unfitted border will result in a cropped photo. This limits the use of digital borders and therefore the art designs. In this paper, we propose a method that automatically resizes the digital border for different paper sizes while preserving the look and feel of the original design. It analyzes the geometric layout and semantic structure of the digital border, and then based on the nature of the structures; it scales and moves them to the right place to reconstruct the digital border to the new page size.

Categories and Subject Descriptors
I.7.2 [**Document preparation**]: Desktop publishing.
I.4.5 [**Reconstruction**]: Transform methods.

General Terms
Algorithms.

Keywords
Document scaling, Document layout, image segmentation and reconstruction.

1. INTRODUCTION
As digital cameras become more sophisticated and photo processing software becomes widely available, photos become more dynamic in size, photo printing is going beyond "4x6" and printed materials are more artistic. To enhance the photo sharing experience and the visual effect of a photo, photo sharing websites now provide user's with graphical digital borders. Digital borders are usually designed by graphic artists for a specific page or photo size; they are not dynamically adjustable, which limits the use of digital borders.

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An example is shown in Figure 1. Digital borders on photo sharing web sites are often prepared for standard photo sizes such as 4x6 or 6x4 as in figure 1(a). However, many photos have non-standard sizes and aspect ratios. Forcing those photos into the digital border creates cropped photos as shown in figure 1(b).

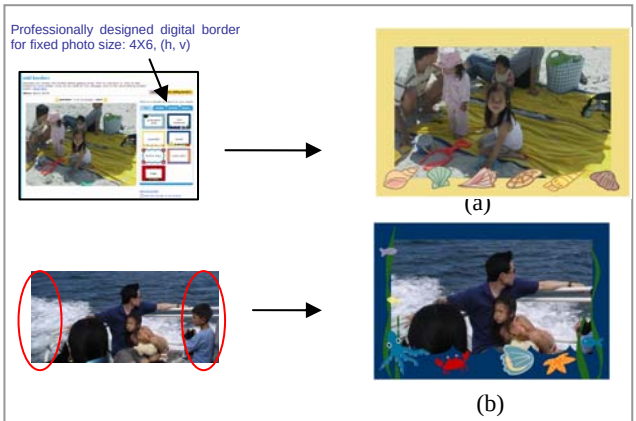

Figure 1. Applying the digital border to a photo with standard size (a) and a photo with non-standard size (b).

Currently, resizing the digital border to a new page size requires sending the job back to the graphic artist for manual adjustment. Otherwise if using standard image processing software, scaling the digital border to a photo size with different aspect ratio often results in a distorted image that loses the original aesthetic appeal of the artistic design.

Previously we have developed a method that captures the look and feel of a document by understanding the layout constraints between different page components [2,3]. Overall layout was preserved by only modifying the white spaces between page elements. Whilst supporting text reflow, it doesn't allow the non-fixed aspect ratio scaling of the image elements on the page. It applies well to block layout office documents but not for digital borders, where different image elements should be treated differently depending on the semantic meanings and the design purposes of the elements.

Symmetry, equilibrium, and the relation of the polygon to a horizontal-vertical network are important components in Birkhoff's original aesthetic order [5]. For page layout: alignment, regularity, balance, proportion and uniformity play

import roles in the aesthetic measure [6]. In this paper, we have proposed a method that automatically resizes the digital border for non-fixed aspect ratio scaling while preserving the look and feel of the original design. It analyzes the geometric layout and semantic structure of the digital border then, based on the nature of different structures, it scales and moves them to the right place to reconstruct the digital border to the new page size. This method preserves the original aesthetics by preserving the semantics of the elements on the page, the relative positions of the elements on the page and the relative positions among elements. Alignment, regularity, uniformity and balance on the page do not change during the scaling and the design intention of the various elements in the image is preserved. The resized image maintains the relative proportions of the original image while still fitting to the new page size.

2. METHOD

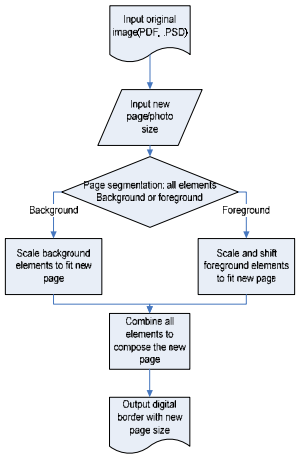

Figure 2. Processing flow chart.

Fig. 2 is a flowchart that describes the basic method for automatically resizing a digital border. The original input digital border image is either in PDF or multilayered Adobe Photoshop format (PSD). The original image is segmented into different logical structures as image elements. Image elements are categorized as background or foreground elements. This segmentation is first based on the different layers of the image in the case of the PSD files and then on the connected components [6]. Background and foreground image elements are identified based on symmetry measure, size measure and complexity measure. Background elements are elements that are symmetrically placed and are close to page size in one of the dimensions (horizontal or vertical) and tend to be simpler in design. The scaling of background elements does not necessarily preserve the aspect ratios of the elements. They are allowed to stretch in the horizontal or vertical direction to fit the new page size. Scaling of the foreground elements requires preserving the original aspect ratio. The background elements are categorized into three broad classes based on the position of the bounding box centers of the elements in the original image as follows:

1. Horizontal: bounding box center lies close to the top or bottom edges of the image compared to the side edges. A horizontal element is sub-classified as a top side element if it lies closer to the top edge than the bottom edge and vice-versa. Top horizontal elements are scaled using the top edge of the image as reference and bottom horizontal elements are scaled using the bottom edge of the image as reference.

2. Vertical: bounding box center lies close to the left or right edges of the image compared to the top or bottom edges. A vertical element is sub-classified as a left side element if it lies closer to the left edge than the right edge and vice-versa. Left vertical elements are scaled using the left edge of the image as reference and right vertical elements are scaled using the right edge of the image as reference.

3. Area: bounding box center lies close to the center of the image, i.e., within a pre-defined rectangular area around it.

Horizontal elements are allowed to stretch in the horizontal direction if the horizontal scale factor is greater than the vertical scale factor. Similarly the vertical area elements are allowed to stretch in the vertical direction if the vertical scale factor is greater than the horizontal scale factor. Figure 3 summarizes the rules for scaling different types of background elements with different scaling factors in the horizontal and vertical directions. The area elements are scaled to fit the new page so that they are placed at the same relative position in the new page and gaps between the element and page edges are in the same proportion as ones in the original page.

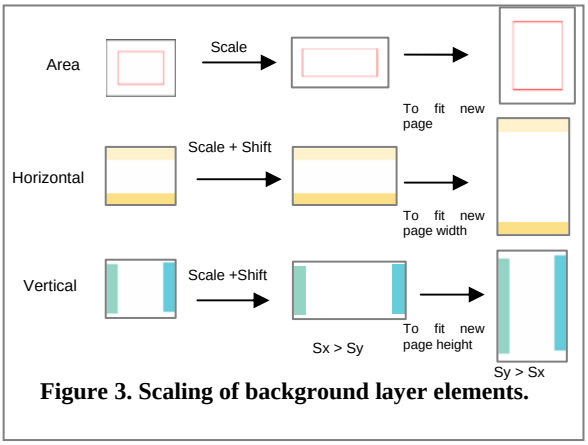

Figure 3. Scaling of background layer elements.

Foreground elements are also classified into three broad categories:

1. Corner: any pair of adjacent element edges is close enough to the nearest corresponding pair of adjacent image edges. Depending on the pair of borders that satisfy this criterion, the corner elements are sub-classified as bottom-left, bottom-right, top-left or top-right. The corresponding image corner becomes the reference scaling axis.

2. Horizontal: bounding box center lies close to the top or bottom edges of the image compared to the side edges. A horizontal element is sub-classified as a top side element if it lies closer to the top edge than the bottom edge and vice-versa. Top horizontal elements are scaled using the top edge of the image as reference and bottom horizontal elements are scaled using the bottom edge of the image as reference.

3. Vertical: bounding box center lies close to the left or right edges of the image compared to the top or bottom edges. A vertical element is sub-classified as a left side element if it lies closer to the left edge than the right edge and vice-versa. Left

vertical elements are scaled using the left border of the image as reference and right vertical elements are scaled using the right border of the image as reference.

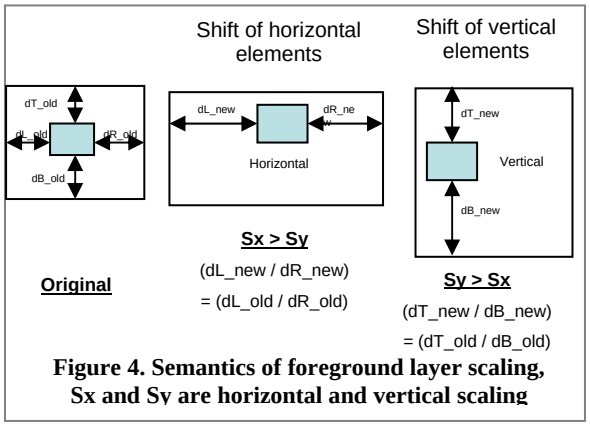

Figure 4. Semantics of foreground layer scaling, Sx and Sy are horizontal and vertical scaling

The aspect ratio of all the foreground elements is preserved by choosing a uniform scaling factor along both the horizontal and vertical directions. The uniform scaling factor is the minimum of the page scaling factors in the horizontal and vertical directions. The corner elements are transformed so that they are at similar relative positions with respect to the corners of the scaled image as in the original image. The vertical and horizontal elements are allowed to shift so that they occupy similar relative positions in the scaled image when the scaling results in a stretch in the vertical or horizontal directions respectively as described in Figure 4. Figure 5 summarizes the rules for scaling different types of foreground elements with different scaling factors in the horizontal and vertical directions.

Different image elements are then placed and overlaid in the same order as in the original image to form the final new border.

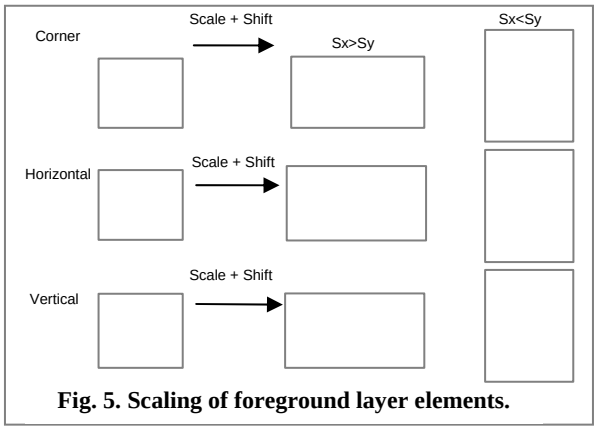

Fig. 5. Scaling of foreground layer elements.

3. RESULTS AND DISCUSSION

In essence, instead of forcing the use of a limited set of fixed size/aspect ratio digital borders for all photos, we are able to automatically resize a border to optimally fit a particular photo. An example is shown in Figure 6. This method allows the user to apply the digital borders to a wider range of photos. It increases photo usage and downloads, and creates more share/print opportunities.

The algorithm has been tested on 10 samples to date. These include images from Microsoft clip arts and digital border collections from the professional designers. Automatically adjusted digital borders give comparable results to those that have been manually adjusted ones. Compared to simple scaling, the proposed method preserves the intended shapes and relative positions of the elements as shown in Figure 7.

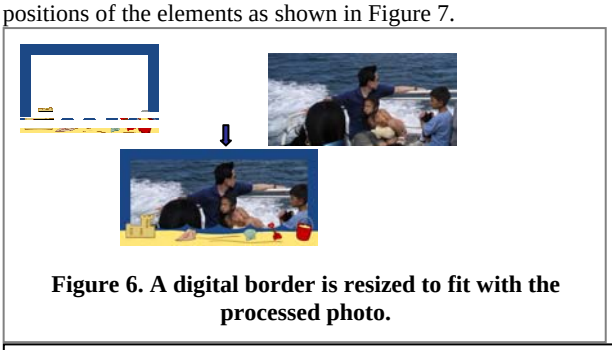

Figure 6. A digital border is resized to fit with the processed photo.

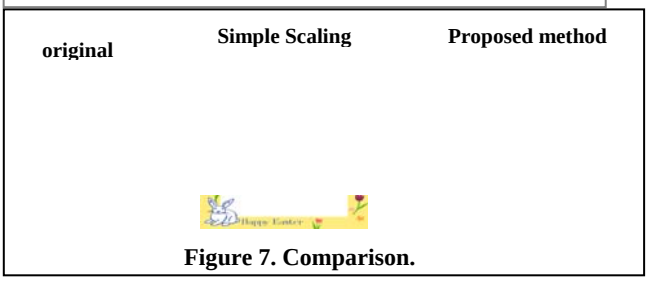

Figure 7. Comparison.

In this paper we have described a method that automatically scales a non-fixed aspect ratio digital border whilst preserving its original *look and feel*. We would like to do further tests on our approach as well as engage with graphic artists and designers to look at how we may improve the results. Some fundamental questions also need to be addressed, such as:

1) How to store an art design for reuse;

2) How to better fit the art work with customer's data for better layout, better color matching, better visual balance, etc.

4. REFERENCES

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