SmartFit: automatic photo fitting for variable data printing

Zachi Karni  
HP Labs Israel  
Technion City, Haifa, Israel

Amir Gaash  
HP-Indigo  
Einstein 10, Ness Ziona, Israel

ABSTRACT

We present an algorithm for smart image fitting: changing the size of an image so that it may fit "naturally" within a given frame. As the frame's dimensions will generally differ from that of the image, the algorithm preserves important details in their original aspect ratio, while less important details undergo more substantial deformations. This problem is useful for many commercial print applications. One example is the HP SmartStream Designer, which is a tool to create variable and personalized content documents.

Keywords: variable data printing, VDP, image retargeting, image warping

1. INTRODUCTION

The HP SmartStream Designer is a tool to create variable and personalized content documents; in particular, it is a plug-in for Adobe InDesign, a primary application for graphic designers. Personalized documents typically include a fixed background with variable content areas that change over this background. The result is that each instance of the job is different. The area that changes must fit well graphically with the fixed background.

The variable data is usually produced by the customer, and for the case of images may come from a variety of sources. For example, images may come from digital cameras, which offer a few standard aspect ratios, such as 3:2, 4:3 or 16:9. In the final variable data job, these images will have to fit into a "frame", kept as a placeholder, with a different aspect ratio. One of the tasks of job creation is to fit the customer's image into the placeholder automatically.

There are a few conventional fitting methods: cropping, white space, and stretching as they are demonstrated in Figure 1 by fitting a 3:2 aspect-ratio image into a 1:1 aspect-ratio frame. Cropping the image (Figure 1b and c) may exclude salient parts of the image. White spacing, i.e. leaving white area in the gaps between the image and the frame (Figure 1e), often looks like a design error since it destroys the graphical flow of the document. Stretching (Figure 1d) may cause artifacts, such as making people look wider or thinner than in real life. People are sensitive about such changes, even if the widening affect is small. Manual Photoshop editing of each image is effective, but very time consuming and are not practical for the case of variable data printing since personalized jobs often include huge number of images, and an automated algorithm is required.

The Automatic Photo Smart Fit algorithm we now describe keeps the important objects undistorted, while stretching the unimportant objects (often the background) to the designed frames, so that the result is visually satisfying to the end user.

2. PRIOR WORK

To the best of our knowledge HP SmartStream Designer is the first to integrate a fully automatic image retargeting approach as an additional layer in the automation of printing workflow. Specifically, the new feature solves an important problem in the automated creation of personalized documents, and differentiates the HP product vis-a-vis its competitors.

The main competitive approach for our retargeting algorithm is that of Seam Carving [1][4], which has been implemented in Adobe Photoshop as "Content Aware Scale". Seam Carving has been quite successful, but has some notable disadvantages: in particular, it discretely removes pixels from the image, leading to artifacts in dense areas as it demonstrated in Figure 2b where the legs of the girl in the left and the head of the second girl from the right vanish. On the other hand, energy-based methods globally and continuously relax the distortions along the entire image and therefore achieve significantly better and much more pleasing results (Figure 2c). Detailed information regarding the different retargeting algorithms is beyond the scope of this paper. The interested reader is referred to the excellent surveys in [5] and [6].
3. OUR METHOD

In our energy-based content-aware image retargeting, the original image is overlaid with a quadrangular grid. The goal is then to deform this grid to fit the target frame and to preserve the aspect ratio of "important quads", i.e. quadrangles that lie on top of key parts of the image, such as faces. Other "unimportant quads" may undergo stronger deformations.

To begin with, therefore, we need a notion of the importance, or saliency, of different parts of the image. Practically, the saliency measure can be as simple as a measure of the magnitude of the image gradient (see Figure 3c); however, we use more powerful segmentation-based saliency measure as it is described in [7].

Given the image saliency, the algorithm computes the deformation of the quadrangular grid by minimizing an energy function, subject to certain hard constraints. The energy captures the idea that we would like each new quadrangle to be as close as possible to an axis-aligned affine transformation, which would leave the new quad as nearly a rectangle as possible. There are two types of hard constraints. The first type of constraint places a bound on the change in the aspect ratio of a quadrangle; if the saliency of that is large, the change in aspect ratio must be small, whereas if the quad is not salient, it is allowed to undergo much more severe deformation. The second type of constraint is a boundary constraint: the side of a quad, which lies on the boundary of the image, must continue to lie on the boundary of the new target frame. This ensures that the resulting quadrangular grid fills the target frame. Error! Reference source not found. demonstrates the different steps of our energy based content aware deformation methods.
Mathematical details of this procedure are contained in [3] and [2]. In the most recent version, the minimization problem is convex, and can be solved by quadratic programming techniques. The key is that a global optimum of the energy can be found, leading to excellent results.

4. RESULTS

Figure 4 shows an Adobe InDesign variable data-printing job and its results, demonstrating the strength of our algorithm. In this job, shown in the top left figure, there are three variable data fields. The first field is at the bottom, and is the image in its original aspect ratio (marked as "Original Image"). The second field is in the left frame, and contains the result of conventional stretching of the original image to the frame (marked as "Regular Fit"). The third field is in the right frame, and contains the result of our Smart Fit algorithm applied to the original image (marked as "HP Smart Fit").

In the top right, bottom left, and bottom right figures we show the resulting pages from this job, created automatically using the Create Job function within the HP SmartStream Designer.

It is easy to see that our Smart Fit algorithm preserves the aspect ratio of the important parts of the image. In the top right and bottom left figures, both the aspect ratio and the area of the faces of the people are preserved, leading to a much more natural looking result than the regular fit. The bottom right figure was a test of the algorithm: we used the job image itself as the variable data. In so doing, we are able to see that the aspect ratio of the frames are preserved using our algorithm, whereas this is not the case with the regular fit.

Readers wishing to test out our algorithm are invited to install Adobe InDesign CS5, and to download the HP SmartStream Designer version 5, available for a free 90-day trial from www.hp.com/go/SmartStreamDesigner. There, one will find both the HP SmartStream Designer installer and a sample file "HP Photo Smart Fit.zip". Finally, a short descriptive movie that presents how to use the "Photo SmartFit" feature can be viewed at www.youtube.com/watch?v=ioXqos5B1jk.
5. SUMMARY

We present an implementation of our image retargeting approach within HP SmartStream Designer as part of variable data printing workflow. HP SmartStream Designer, version 5, which includes the SmartFit feature, was recently released on both the Windows and Mac OS X platforms.

REFERENCES