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Comparative Study of Image Resizing

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Abstract— ***The diversity of display devices and vivid needs in image processing has given rise to a variety of image resizing techniques. Image resizing has a very important role in digital image processing. Lots of image resizing algorithms are available. Every algorithm has some advantages and disadvantages. This paper presents a comparative study and results of four image resizing algorithms, namely- Warping Based, Seam carving, Content Based, Saliency Driven. The present paper has the four techniques with examples, and describes the recent advances in the field. Image resizing algorithms may have the same components like: feature specification, warp generation and control of transition. But, the difference in the output image is due to the method of processing an input image and focusing-feature of an algorithm. The paper executes an exhaustive comparative analysis of the four methods and presents its conclusion.***

Keywords— ***Image resizing, Similarity transformation, Patch-linking scheme, Shape preserving, linear system.***

I. INTRODUCTION

The display devices available with electronic gadgets tend to individuation and diversification. Original images usually have higher resolutions and different aspect ratios. Small screens cannot provide enough resolution to make the image meet the visual demand. As different aspect ratios may introduce image distortion, it is necessary to develop proper methods to solve the problems effectively. This paper, discuss image resizing methods that adaptively resizes the input image in such a manner that global image configuration is better preserved and the distortion is least-likely to be noticed. Image resizing can be formulated as a quadratic minimization problem aiming to minimize the overall visual distortion.

II. RESIZING PRINCIPAL

In the emerging field of Image resizing, machine recognition of image is a challenging task. Yet image resizing systems are been grabbing high attention from commercial market, as well as research community. Human recognition system is a biometric identification system that recognizes the components of any image effectively and helps in further processing. Among the existing biometric systems, image resizing system is user friendly.

There are three ways to resize an image, and all three have very different meanings and outputs**.**

- **Cropping** – Cropping refers to cutting down the edges of an image so as to reduce it's the dimensions. It is similar to cutting a piece of paper to reduce its size. Though cropping makes the image dimensions smaller, but it changes the scene included, and often the shape too. Camera always provides images the same aspect ratio, but many times this need a photograph with specific dimension. On one hand cropping reduces the size of the image but also affects the composition and characteristics of the image.
- **Resampling** –Resampling means to create a new image of different image dimensions (in pixels). For example, resampling of a picture of 5000 pixels can be resampled for an output image with 1000 pixels. The new image shall be smaller than the original image yet it will show the entire components of the scene. Re sampling is not reversible. The resampled image which is smaller copy has plenty of pixels for the smaller size of course, but less than before.
- **Scaling –**Scaling is sometimes known as Resizing. It is a process of changing the size (dimension) of the image so that it can be printed in a required dimension without affecting the pixels. Scaling is about declaring the dpi number. This is a simple operation but sometimes it results in distorted image.

Deselaers et al.[1] presented a cropping based video resizing method that find an optimal sequence of cropping window that best preserves image information and apparent camera motion. There are basically three types.

Shape Distortion: Each source image patch is a rectangle with width ω and height h. Each patch undergoing similarity transformation is used to keep its shape. This methods extend the similarity transformation constraint presented by Igarashi T et al.[2].

Orientation Distortion: Orientation distortion is another distortion that disturbs understanding of image content Shirley et al[3].

Scale Distortion: Wang et al.[4] calculated optimal local scaling factor for each local region. This strategy scales different parts of an image differently and might change the proportions among diffract parts. Krähenbühl et al.[5] calculated one global scaling factor.

III. METHODS TO RESIZE AN IMAGE

III-1. WARPING BASED TECHNIQUE

This method adapts an image to a display with different size and aspect ratio by non-homogeneous warping. Specifically, this method builds a uniform mesh from the original image, defines quadratic distortion measures in a variety of images over the mesh, and solves an optimization problem to gives minimum visual distortion. It compute an importance map and spreads the distortion according to importance value of each patch of the image. The importance map is composed of low level scale-invariant local saliency and high-level recognizable objects information. The technique is very useful in projecting image a display of different sizes.

This method also uses different strategies for upsizing and downsizing the properties of the target displays. When downsizing images to small displays, besides minimizing visual distortion, its important content are given higher resolution than its surroundings to maintain the recognizability of important content. In upsizing images to large displays, we need to minimize the visual distortions and visual artifacts, such as blurring. This method could fail if the input image is full of salient features. Since there is no unimportant homogeneous region to concentrate the distortions, this method will achieve result similar to homogeneous resizing.

Figure.1 (a) input image(4:3) (b) No patch-linking scheme (16:9) (c) with patch-linking scheme (16:9)

Figure.1 Effectiveness of patch-linking scheme (a)is the original image whose aspect ratio is 4:3 (b) and (c) are results whose aspect ratios are 16:9. Without patch-linking scheme, the result b distorts the boundary of bricks. Introducing patch links c can better preserve this large-scale structure

III-2. B. SEAM CARVING BASED TECHNUQUE

With the rise of mobile devices, content-aware image resizing, or image retargeting, is becoming an important research area. More than ever there is a need to resize images and videos fit to various device displays with different aspect ratios in such a way that maximizes information and minimizes distortion. Traditional methods including resampling and cropping had been the only option up until a few years ago but now modern methods like seam carving have contributed in the output quality.

In their seminal work of 2007, Avidan and Shamir proposed a rather elegant solution called seam carving, which operates in a discrete fashion, reducing (or enlarging) an image's dimension by one row or column at each step [8][9]. Later solutions by Wolf et al. [6], Simakov D et al. [7] produce good results by employing global optimization techniques but are expensive. Furthermore, global solutions are not well-suited for multi-scale media applications those that allow an image or video to be retargeted to any size because they would require reprocessing for each change in size. Seam carving, technique only requires a single preprocessing stage to prepare images or video such that real-time retargeting is possible [8].

Seam carving works by finding the lowest-energy connected path of pixels from either left to right (*horizontal seam*) or top to bottom (*vertical seam*), removing those pixels, and repeating the process until the desired image size is achieved. In order to maintain the rectangular structure of an image, it is also required that each path of pixels include exactly one pixel per column for horizontal seams, or one pixel per row for vertical seams. In a similar manner, pixels can be added along these seams to increase the image size. While image enlargement and reduction are both important, seam carving applies very similar objectives for both [8].

There are two primary criteria for describing the energy of a seam: backward-energy and forward-energy. The backward-energy criterion uses an energy map defined in [8] as

$$e(i; x, y) = \left|\frac{\partial}{\partial x} I\right| + \left|\frac{\partial}{\partial y} I\right| \quad \textbf{(1)}$$

which is the L1-norm of the image gradient. This generally works well because important objects usually have a well-defined edge and, consequently, a high gradient value along that edge. Using this map, dynamic programming is employed to find the minimum-energy path. A vertical path of pixels of an $m \times n$ image is defined as the set of locations

$$s = \{si = (i, xi)\}1 \leq i \leq m \quad \textbf{(2)}$$

Where$x$iis determined during the dynamic programming stage [8].

The forward-energy measure [2] does not directly use an energy map. Instead, it finds the seam that minimizes the absolute differences between the pixels brought together upon the removal of the seam. One can still measure the energy of individual seam pixels using the cost map ***M*** as defined in [9]. Since each point of this map corresponds to the minimum cumulative energy of a seam ending at that point, the individual energy of each point along a seam as

$$e(I; s_i) = M(s_i) - M(s_{i-1}) \quad \textbf{(3)}$$

Where s_i is the location of the i-th pixel in the seam $\boldsymbol{s}$.

Figure 2: (a) Original image (left) and (b) a 30% width reduction using backward-energy seam carving (middle). (c) The red boxed areas are enlarged to show detail (right).

There are the premiere methods that have been introduced with the invention of seam carving itself. The results were very positive, being comparable or better than previous seam carving implementations. The algorithm allows implementing any optimal seam-finding method as well as augmenting higher-level feature detectors [10].
While seam carving remains an important tool for image retargeting, it has its limitations. High level features like face detection doesn't give proper result. In many cases the method fails in practice. Moreover, the detection of such high-level features may fail in practice and thus cause the entire scheme to fail. Still, high-level features can be augmented with any seam carving algorithm and is no exception. This new seam carving algorithm improves edge preservation and decreases artifacts.

III-3. CONTENT-BASED TECHNIQUE
This method considers the image as a set of lines L = [l1; l2;: : : ; l_n] where li represents a single line and n is the dimension of the rows or columns of the original image to be resized. Content based approach aims to find a novel set of lines L_0 = [$l_0$1 ; $l_0$2; : : : ; l_0 n_0], where n_0 is the desiderate final image dimension, obtained from the original set L by removing (or adding in case of image enlargement) some lines without introducing, if possible, image distortions.

The selection of the lines to be removed is hence a fundamental step of this approach. A careful selection, considering non-informative regions, should preserve the overall quality of the final image. A significance map is then built using a measure based on visual salience [11] and gradient information. A weight wi is associated to each line li through the projection along the considered line by using simple operators (i.e., mean, max, min).

Tests of this considered and compared to properly find a deal between final image quality and complexity of the approach. Starting from the set of weights **W** = [w_1, w2… w_n] two different strategies of line removal (insertion) have been designed. The simplest one removes the |*n'* – *n*| lines corresponding to the lowest weights (hence less "significant" in terms of salience and gradient information).

The second strategy considers the removal (replication) step as an iterative process. For each iteration it removes (or replicates) the less "significant" line based on its weight value and then updates the whole map of importance of pixels and the set of weights W. Experiments figure 3 show the difference between the above mentioned strategies both in terms of visual quality (artifacts generation) and computational time on a mobile device.

Figure 3(a) Original Image **(b) Non-Iterative approach** **(c) Iterative approach**

Results obtained considering both non-iterative (Figure 3(b)) and iterative (Figure 3(c)) approaches. The original image shown in Figure 3(a) is reduced of 20%.

III-4. Saliency-driven Shape Preservation Based Image Resizing

Saliency-driven image resizing method discussed the shapes of prominent objects in target image are similar to their original shapes. This method is also based on mesh deformation technique. But unlike, allow quads to undergo a similarity transformation. It is presents a new image resizing method, which preserves important local regions and better diffuses distortion into less important regions. In addition to this, the minimization problem of energy function, in this method, is a linear system, which is enough efficient for resizing image into arbitrary aspect ratios.

Mesh deformation technology is adopted to solve the problem on shape-preserving image resizing. The image is covered with a planar quadrilateral mesh, denoted by $M = (V, E, F)$. Where V is the set of vertices, E the edge set and F the face set. Further denote edge with vertices υ_1 and υ_2 as two endpoints by $\upsilon_1\upsilon_2$. The deformed mesh M'=(V', E', F') has such relation with initial mesh M : E' = E, F'=F. For $\upsilon \in V$,υ' is as counterpart in V'. In additional, the vertex salience and similarity transformation constraint are about interior vertices of the mesh, not include the boundary vertices. So this denotes the interior vertices as V_{in}, where $V_{in} \subset V$.

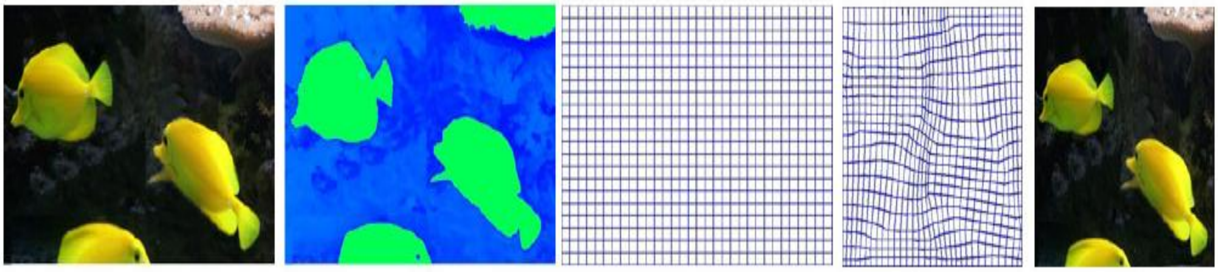

Figure 4 (a) (b) (c) (d) (e)

Figure 4 the pipeline of salience driven method. From left to right the images are (a)original image, (b)image salience, (c)initial mesh, (d)deformed mesh and (e)target image in turn.

The pipeline is illustrated in Figure 4. First the visual saliency features of given image are estimated. Next a feature preserving mesh deformation to the target size is computed by minimizing an objective function E about similarity transformation constraint. Last the resulting image is rendered on the target mesh using a standard texture mapping algorithm.

IV. CONCLUSIONS

This paper made a comparative analysis of the four most popular image resizing methods, namely – Warping Based, Seam Carving, Content Based and Salience Driven Method. All the methods were tested for different input images. It was observed that the use of different algorithms for a single input image gives different results, depending upon the method used. This leads to the conclusion that different methods are required for different input images. Hence it is hard to say that any particular method can give best result in all conditions. It was seen that Warping Based technique is effective in case of enlarging the selected context. The seam carving method is very effective in case of overcoming the distortion, missing or undesired image anomalies. The third method fall under the scope of this paper is content based method. It was found that the method proves its effectiveness in eliminating any undesired objects in an image thereby overlapping the undesired object by the nearest energy level. The Saliency Driven method is effective for minimizing the salient regions. Unlike Content Based method the salience driven method reduces the repeated energy level. The effectiveness of the output depends largely upon the method. The technical knowledge of the user also plays an important role in the quality of output image.

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