Seam Cerving And Salient Detection For Thumbnail Photos

Much Chafid[(1)], Abdul Syukur[(2)], Moch Arief Soeleman[(3)], Affandy[(4)]

Universitas Dian Nuswantoro, Indonesia

*E-mail: [(1)]chafid53@gmail.com , [(2)]abdul.syukur@dsn.dinus.ac.id,
[(3)]m.arief.soeleman@dsn.dinus.ac.id, [(4)]affandy@dsn.dinus.ac.id,*

Abstract

Image resizing is a process of processing images or images with the aim of changing the size of the image. The most commonly used methods are cropping or scaling. Scaling is changing the size of the image based on the scale. Contents in the image are not considered in scaling. Seam carving often uses energy functionality that is useful as a determinant of the pixel level contained in an image. Seam is a connecting path of image pixels both vertically and horizontally that is passed by a low energy function. Changing the image size using seam carving is considered better than cropping and scaling. However, the seam carving method still cannot protect the object that is considered the most important. In overcoming this weakness, we can use a combination of seam carving algorithm with salient detection. In this research, we will improve the two methods which function as thumbnail maker. The results of the salient detection of the most important areas of the image will be detected and as a reference in resizing the image (seam carving) The dataset uses 200 images. The accuracy value is calculated by distributing questionnaires to 100 respondents and producing an acceptance rate of 78% so that the results are very natural/natural.

Keywords: Thumbnails, Seam Carving, Salient Detection

Introduction

Currently, many internet users use electronic devices, both mobile phones, computers, and laptops to access web pages that tend to have digital images or photos in them. So that in accessing web pages it is not too large, then creating thumbnails is one way to make image browsing more efficient because the image size is not too large. Thumbnails are images / photos with a size that has a small capacity size of an image with a function only for interfaces on a web page.

Image resizing is a process of processing images or images with the aim of changing the size of the image. The most commonly used methods are cropping or scaling. The function of cropping is to remove pixels within certain limits in an image (Achanta & Süsstrunk, 2009). Scaling is changing the size of the image based on the scale. Contents in the image are not considered in scaling. As a result, the resulting thumbnail photos have not been able to convey the information that is considered the most important.

Seam carving is a method that functions to change the size of the image by adding or removing a carve of several pixels from different digital image elements. Seam carving often uses energy functionality that is useful as a determinant of the pixel level contained in an image. Seam is a connecting path of image pixels both vertically and horizontally that is passed by a low energy function (Yin & Li, 2013). Changing the image size using seam carving is considered better than cropping and scaling. However, the seam carving method still cannot protect the object that is considered the most important.

In overcoming the weaknesses above, it is

possible to use a combination of seam carving algorithm with salient detection. In this research, we will improve the two methods which function as thumbnail maker. The results of the salient detection of the most important areas of the image will be detected and as a reference in resizing the image (seam carving). Seam carving will resize the image based on the specified target size length x height.

Material and Method
Salient Detection

In psychology and the field of observation it has been found that (Achanta, Estrada, Wils, & Süsstrunk, 2008), (Rokhim, 2015) salient detection is when we look at an image, our visual system will first quickly focus on one or more "interesting" areas before further exploring the content. the entire image and this area is often called salient detection (Zhang, Gu, & Li, 2013).

Salient detection is useful in many high-level image processing tasks including image segmentation and object recognition. It can be used as a preprocessing step to reduce search space. One of the important applications of salient detection is image retargeting.

Seam Carving

*Seam*mis a vertical or horizontal path that is connected in each pixel (Avidan & Shamir, 2007). The seam connecting the top and bottom rows of pixels is called a horizontal seam. The number of pixels passed by the seam is equal to the horizontal image height and image width (for horizontal seams). The seam which has the smallest amount of cumulative energy is called the optimal seam. Carving is the process of reducing or increasing pixels that are exceeded by the optimal seam. The seam carving technique is where to remove unnoticeable pixels that are mixed with the surrounding area. The following that can be used as an example in seam carving can be seen in Figure 2.

Seam carving can be used to enlarge and reduce the image, delete objects in the image and others (Avidan & Shamir, 2007) (Sebastian, Santosa, & R., 2016).

Algorithm 1 Seam Carving Algorithm
1. Count Energy From Each Pixel
2. Vertical Seam Determination
3. Horizontal Seam Determination
4. Seam Removal

In Algorithm 1 it is explained that the stages ywhat is in seam carving is to calculate the energy for each pixel, then generate a list of seams whose order is based on energy. Seam calculation is done vertically and horizontally.

Seam vertical sv of image I with size n x m is shown in Equation 1 where i and $col(i)$ are row coordinates and column coordinates, respectively.

$$s^v = \{(i, col(i))\}_{i=1}^n, s, t, \forall i, |col(i) - col(i-1)| \le 1$$

(1)

During the removal of low-energy seams, important image content is retained during the resizing process. For that, the energy of each pixel can be calculated by the energy function e according to Equation 2.

$$e(I) = \left|\frac{\partial}{\partial x}\right| + \left|\frac{\partial}{\partial y}\right|$$

(2)

Where $\frac{\partial}{\partial x}$ and $\frac{\partial}{\partial y}$ are the derivatives of the row and column.

From the energy function e of each pixel in Equation 2, the energy of the seam vertical $E(s)$ can be calculated using Equation 1. Seam vertical with path lowest energy s* = $minE(s)$ is ob-
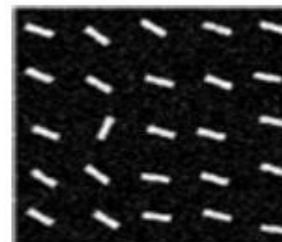

Figure 1. Salient Region Example
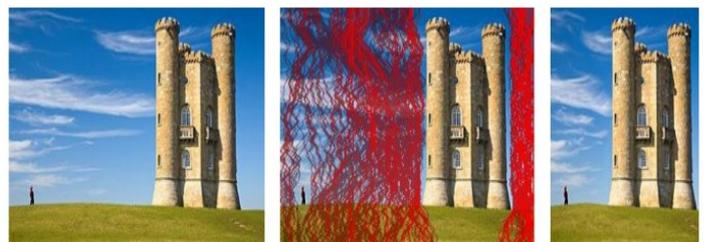

(a)   (b)   (c)

Figure 2. Resizing Using Seam Carving: (a) Input Image, (b) Removed Image, and (c) Image After Seam Carving Process

tained using dynamic programming with the recurrence relation M calculated by Equation 3.

$$M(i,j) = e(i,j) + \min \begin{cases} M(i-1, j-1) \\ M(i-1, j) \\ M(i-1, j+1) \end{cases}$$ (3)

After calculating the minimum cumulative energy value M for all possible seam, seam with the lowest energy s* is found from the lowest value in the last row of the M matrix. The lowest energy is then used for the seam removal process without removing important content in the image.

Dataset

Dataset in this study, 200 images were taken from the internet. With a percentage of 35% of images with objects, 30% of images with landscapes, and 35% of images with faces

Research Design

Furthermore, the process of detecting important areas of an image using saliency detection is carried out. Then the results of the important areas of the salient are used as benchmarks in seam carving. After that, the output image will be obtained in accordance with the expected size. Then analyzed the results of the output image whether it is in accordance with what is expected.(Figure 3)

Results and Discussion
Trials

At this stage the user will input the image and then do saliency detection using methods based on Lighting and Color (Achanta & Süsstrunk, 2009), Lighting, Color and Map Orientation (Yin & Li, 2013), Lighting, Color, and Contrast (Yan, 2010). The next step is to open the Groundtruth image to determine the initial truth value and then look for the RMSE of Lighting and Color (Achanta & Süsstrunk, 2009), Lighting, Color and Map Orientation (Yin & Li, 2013), Lighting, Color, and Contrast (Yan, 2010). used as a reference for seam carving after that perform seam carving according to the target and pay attention to the most important areas (salient detection) to get the results of the last stage of seam carving images, namely opening the groundtruth of the seam carving image to find the RMSE value of seam carving (Figure 4 & Figure 5).

Questionnaire Calculation

To calculate the accuracy value, it is done by distributing questionnaires to 100 respondents about the naturalness of the images produced by the system. However, not all images from the 200 datasets appear in this questionnaire due to psychological considerations from the respondents
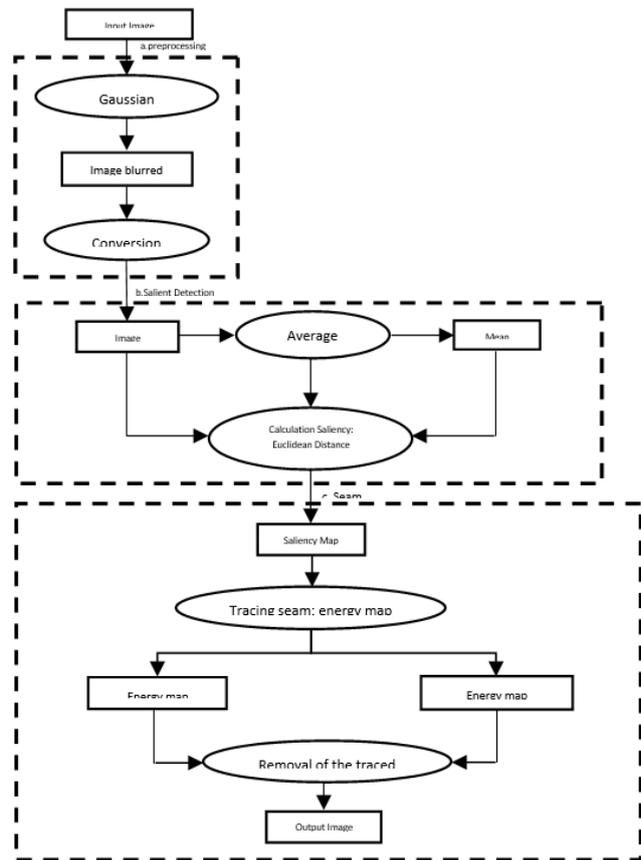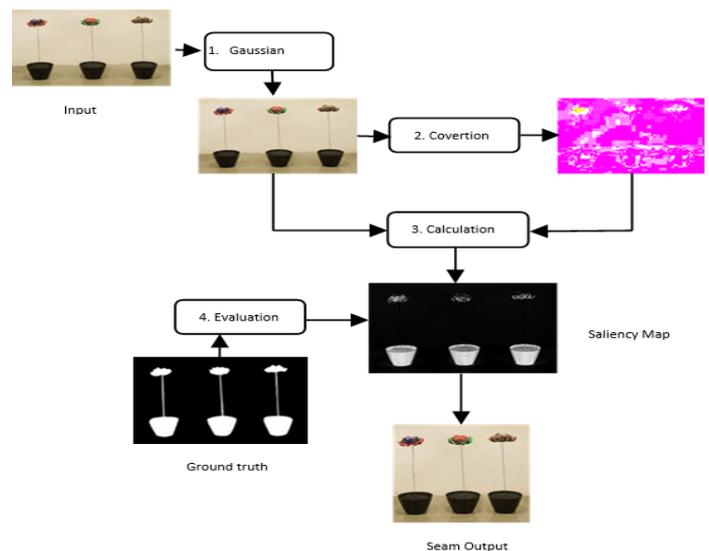

Figure 3. Overall Research Flow

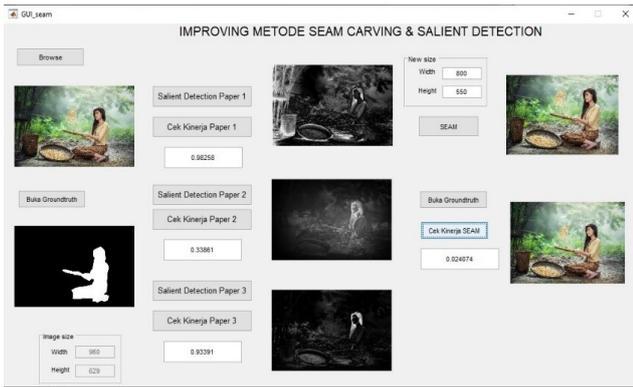Figure 4. Results of the salient and seam carving process

Figure 5. Display of Test Results

and the validity of the answers generated. The more questionnaires submitted will increase the thickness of the questionnaire, of course this can reduce responses and increase the emotions of the respondents. If this happens, the level of answer validity will decrease due to the appearance of random answers..

The questions in this questionnaire use a rating scale. The type of rating scale chosen is a rating scale with 4 choices (even). On a 4-choice rating scale, respondents were not given a neutral answer choice or an intermediate choice which is often chosen by respondents, especially general respondents. Thus, the level of validity of the answers will be better than the rating scale with the number of odd (odd) choices. The specifications for the respondents are a. male or female aged 20-50 years b. Minimum education high school equivalent. Analysis of the results of the questionnaire in assessing the naturalness and naturalness of an image resulting from seam carving. Where the questionnaire was submitted to 100 respondents with 30 different images, namely 10 images containing faces, 10 images with images of objects and 10 images of landscapes. Each image will be assessed for its naturalness and the naturalness of the results of the seam carving process.

Where each question will display 4 answer options: Very Unnatural/Natural, Less Natural/Natural, Fairly Natural/Natural, Very Natural/Natural (Rokhmah, Zaman, & Pranoto, 2020). So that the resulting answer as in Table 1.

So that the criteria for interpreting scores based on intervals are obtained, namely:

- Number 0%-24.99% = Very Unnatural/ Natural
- Number 25%-49.99% = Less Natural/ Natural

Table 1. Questionnaire Results

Image / Rating	Very Unnatural / Natural (score 1)	Less Natural / Natural (score 2)	Quite Natural / Natural (score 3)	Very Natural / Natural (score 4)	Total Score
Figure 1	3	11	52	34	317
Figure 2	2	3	41	54	347
Figure 3	1	10	45	44	332
Figure 4	13	47	24	16	243
Figure 5	2	14	49	35	317
Figure 6	2	13	50	35	318
Figure 7	6	23	43	28	293
Figure 8	0	5	49	46	341
Figure 9	0	7	50	43	336
Figure 10	3	30	53	14	278
Figure 11	6	24	56	14	278
Figure 12	1	13	45	41	326
Figure 13	15	34	41	10	246
Figure 14	1	3	42	54	349
Figure 15	0	3	42	55	352
Figure 16	2	14	32	52	334
Figure 17	19	30	35	16	248
Figure 18	3	10	36	51	335
Figure 19	2	3	42	53	346
Figure 20	0	2	31	67	365
Figure 21	4	14	49	33	311
Figure 22	13	21	39	27	280
Figure 23	2	6	47	45	335
Figure 24	1	11	40	48	335
Figure 25	12	29	36	23	270
Figure 26	15	26	36	23	267
Figure 27	2	11	43	44	329
Figure 28	0	14	46	40	326
Figure 29	5	13	41	41	318
Figure 30	4	17	50	29	304

- Numbers 50%-74.99% = Quite Natural/ Natural
- Numbers 75%-100% = Very Natural/ Natural

Overall, from the 30 images carried out by the questionnaire, interval and average values can be generated, namely in Table 2.

Table 2. Interval Value and Average Questionnaire

Image to	Interval Value
1	0.7925
2	0.8675
3	0.83
4	0.6075
5	0.7925
6	0.795
7	0.7325
8	0.8525
9	0.84
10	0.695
11	0.695
12	0.815
13	0.615
14	0.8725
15	0.88
16	0.835
17	0.62
18	0.8375
19	0.865
20	0.9125
21	0.7775
22	0.7
23	0.8375
24	0.8375
25	0.675
26	0.6675
27	0.8225
28	0.815
29	0.795
30	0.76
Average	0.781333333

Conclusion

From the research that has been done by the author, it can be concluded that:

From the test results using 3 different salient detection methods that to find the most important areas with salient detection, the method with better results based on RMSE is to use the salient method which uses features based on lighting, color and map orientation, referring to the Image Re-targeting Based paper. on the Novel Saliency Map, Kai YIN and Ying LI (Yin & Li, 2013).

Based on the results of a questionnaire with 30 images resulting in an acceptance rate of 78%, so that it can be seen from the score interpretation criteria based on intervals, the results are Very Natural/Natural. In making thumbnails, you can use the seam carving algorithm combined with salient detection.

Suggestion

In further development, seam carving can also be implemented using video input instead of images.

References

Achanta, R., Estrada, F., Wils, P., & Süsstrunk, S. (2008). Salient region detection and segmentation. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *5008 LNCS*, 66–75. https://doi.org/10.1007/978-3-540-79547-6_7

Achanta, R., & Süsstrunk, S. (2009). Saliency detection for content-aware image resizing. *Proceedings - International Conference on Image Processing, ICIP*, (Ic), 1005–1008. https://doi.org/10.1109/ICIP.2009.5413815

Avidan, S., & Shamir, A. (2007). Seam carving for content-aware image resizing. *ACM Transactions on Graphics*, *26*(3). https://doi.org/10.1145/1276377.1276390

Rokhim, A. (2015). *Analisa Letak Papan Reklame Iklan Produk Berdasarkan Salient Region Detection*. 52–58. Retrieved from https://ideatech.stts.edu/proceeding2015/052 - Abdul Rokhim.pdf

Rokhmah, E. Y., Zaman, L., & Pranoto, Y. M. (2020). Implementasi Content Aware Pada Pembuatan Thumbnail Menggunakan Metode Seam Carving and Salient Detection. *INOVTEK - Seri Elektro*, *2*(2), 94.

https://doi.org/10.35314/ise.v2i2.1440

Sebastian, F. A., Santosa, R. G., & R., T. H. (2016). Perbandingan Algoritma Shortest Path Dalam Pemrosesan Citra Digital Seam Carving. *Jurnal Informatika*, *11*(2). https://doi.org/10.21460/inf.2015.112.449

Yan, H. (2010). Adaptive image retargeting using saliency-based continuous seam carving. *Optical Engineering*, *49*(1), 017002. https://doi.org/10.1117/1.3281667

Yin, K., & Li, Y. (2013). Image re-targeting based on the novel saliency map. *Journal of Computational Information Systems*, *9*(9), 3595–3602. https://doi.org/10.12733/jcis5927

Zhang, L., Gu, Z., & Li, H. (2013). SDSP: A novel saliency detection method by combining simple priors. *2013 IEEE International Conference on Image Processing, ICIP 2013 - Proceedings*, 171–175. https://doi.org/10.1109/ICIP.2013.6738036