Optimization of Salient Object Segmentation By using the influence of color in Digital Image

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***Abstract*—Human attention is more likely to be interested in different objects or striking in image processing called salient object. Existing approaches worked well in finding the salient object in this image, but they have not been able to accurately detect where objects should stand out due to the influence of light intensity, there are various object results of salient object detection in which area is still cut off or do not appear because they do not include salient area. We offer solutions to fix these problems by optimizing salient object detection prioritizing object area after salient area, through checking comparison of the color region located around the area of the salient. This Optimization of the application is able to improve to 83% from 100 salient object which has this problem, and able to produce more natural Saliency Cut.**

Keywords—Optimization Salient Object, Salient Object Detection, Mean Shift Color Segmentation, Chain Code, Saliency Region

I. INTRODUCTION

The main problem in various computer vision tasks is how to extract meaningful description, which can be understood by the layman from the image or sequence of images [18]. To describe the object, the system must be able to determine which objects will be described first. We know that "Humans can, of course, learn and generalize well from examples, and they are also capable of identifying completely new classes when provided with a high-level description" [19]. Image segmentation is a technique used for partitioning the image area to a certain unique areas. Segmentation should be able to separate the area which is regarded as an interesting object in the application for the purpose of making images simpler and easier to be analyzed.

Nowadays, many segmentation techniques available, but none of them were able to meet the natural shape of the object, so it remains a challenge for researchers [22]. Human attention is more likely to be interested in different objects or striking in image processing called the salient object [6]. Research concerning the interests of eyes to the salient object, has been studied by researchers in physiology, psychology, nervous system, and computer vision for a long time as described in Section II. Various approaches have worked well in finding the salient locations of some synthetic and natural images, but they have not been able to accurately detect where objects should stand [8,17]. From each of these developments the influence of light intensity still cannot be solved, and there are various object results of salient object detection that are still clipped or not displayed, because it does not include salient area [2].

This study offers a solution to fix the problems that emerged in the results of the saliency. That is done the optimization of salient object detection with emphasis on object area after salient area in determining the actual object area of the object in question by checking the value of the color region around the salient area, and processing the color similarity of the salient area with the region that surrounds the salient objects with the help of chain code. This study can provide the proper object cuts, in accordance with human vision. Examples of the weaknesses of the salient object detection result, of some existing algorithms, are given in Section III. Optimization solutions that we offer are described in section IV. And eventually, Section V will present the results of the optimization we did, accompanied with conclusions in Section VI.

II. Salient Object Detection

Salient object can generally be calculated from the center-surround operation, self-information, or graphical random walk using some features [21]. In the salient object detection process, the first step, each image element is described as a feature vector. The whole picture is considered as datasets and image elements are classified as a saliency pattern if the corresponding feature vector is an outlier in the dataset.

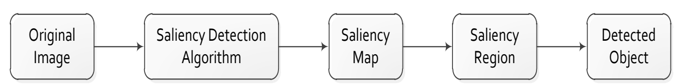


Fig 1. General Scheme of Salient Object Detection.

In various experiments segmentations of salient objects, always obtained the lighting effect that makes the saliency be inaccurate. There are some parts of the object is not shown in the results salient object detection, because the area is no longer part of any salient area. It is not compatible with the concept of human vision, which is capable of performing object segmentation with clean and intact. There are many applications that use visual interest or salient objects that have been developed at this time, such as, automatic image cropping [24], adaptive image display on small devices [7], image / video compression, advertising design [16], and images collection browsing [23].

Various approaches to detect salient area of various objects have been done, including structural salient object detection [25], A Model of Saliency-Based Visual Attention for Rapid Scene Analysis [17], Saliency Based on Information Maximization [4], Graph-based visual saliency [12], A spectral residual approach saliency detection [15], multi-task saliency pursuit method [20], Frequency-tuned salient region detection [1], Highlighting sparse salient regions [14], adaptive clustering saliency [5], outlier detection saliency [6], the soft image abstraction salient detection [9], and several optimizations such as Robust Background Detection Optimization [26], and global contrast based optimization [8].

In general the salient object detection approach will produce a saliency map, which is then processed into a saliency region and applied to the image using the saliency cut, one of them by using the concept of automatic saliency cut [11]. Scheme in Fig 1, describes processes are carried out to obtain a salient object, the chart explained that the process starts from the original input image is processed with the saliency Detection Algorithm to produce the saliency map. Then the saliency map is processed to obtain saliency Region, in the end, from the saliency Region performed saliency Cut to get Salient Object.

III. THE WEAKNESS OF THE SALIENT OBJECT DETECTION RESULTS

From the various developments salient object detection, the influence of light intensity still cannot be solved, and there are various salient object detection results, which area of the object is clipped, or not displayed because it are not included as salient area [2], so it needs to be improved, so that cuts area of the object can be produced with more natural. Some of these errors can be shown in Fig 2, Fig 3 and Fig 4 which marked with a red circle. Problems like this do not just happen on Itti method [17], Achanta [1], and Lang [20] which shown in Fig 2, Fig 3 and Fig 4. It also occurs in some of the results of the most current methods such as Cheng [8], Chen [6] and Zhu [26] and also some other methods.

IV. SALIENT OBJECT DETECTION OPTIMIZATION

To overcome these deficiencies in the saliency results obtained from the Salient Object Detection, the process of optimization results saliency region needs to be done. If the color values contained in the object is viewed using the mean shift color segmentation [11], we found an interesting difference between the original image, and cuts salient objects that should be generated. As shown in Fig 5, colors contained on Mean Shift Color Segmentation apparently showing that the value of color left by the salient area is the color that has a low contrast and lighting.

Fig 2. Missing Area in Multitask object In Pursuit Salient sparsity Consistent Detection.

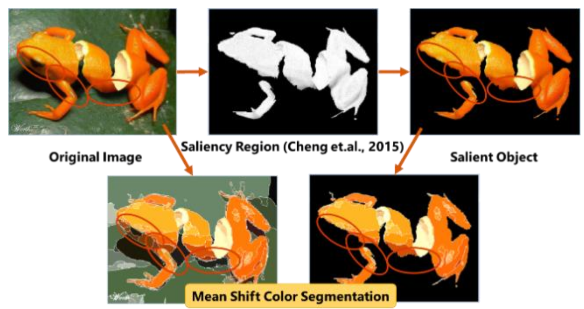


Fig 5. Mean Shift Segmentation Results of Original Image Color and Salient Object.

In this study, we did a little additional optimization process to obtain the area, so that the unity of the object can be displayed. We perform a search of color values contained in the salient objects by using Mean Shift segmentation Color.

Fig 3. The loss Area Objects in Itti's saliency Map and Achanta's saliency Map

Fig 4. The loss Area Objects in Chao 2013

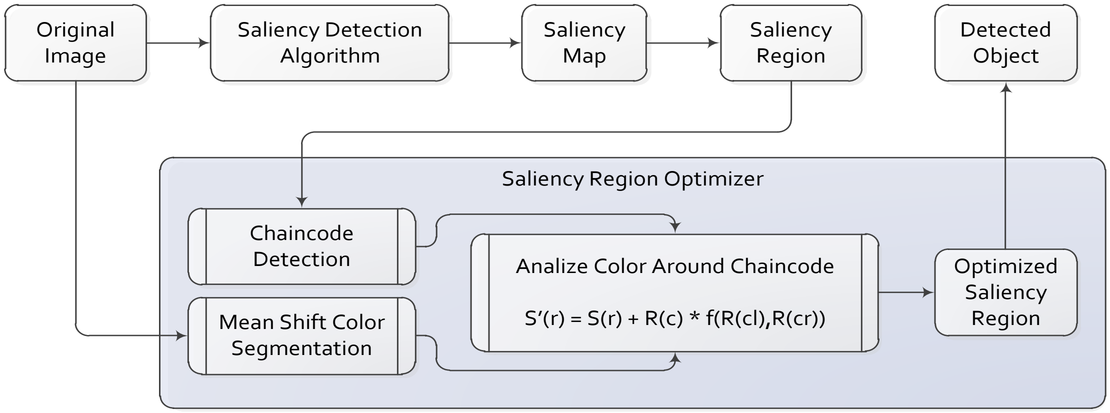


Fig 6. Optimization scheme for Salient Object Detection

It can be concluded that the suggested solutions have made is an additional optimization process by examining the linkages entire side of salient objects with the color around it, that is by exploiting Mean Shift Color Segmentation of the object itself and the original image based Chain code of salient objects produced. The proposed optimization process requires image results of salient region, as the result of the salient object detection process and results of the mean shift color segmentation from the original input image. So the process is done will change from the salient object detection scheme in Fig 1, become the salient object detection process, with the optimization scheme in Fig 6.

A. Mean Shift Color Segmentation

Mean Shift is a technique for analysis of feature spaces [10]. When Mean Shift is used for color image segmentation, image data is mapped into the feature space, so that it can be formed into the cluster pattern. And the Cluster will be fit with the significant features in the image, a feature which has a dominant color. By using the Mean Shift procedure, we can find several groups of color, because these procedures take the dominant color of the images used as the basis for segmentation. The Cluster is formed by applying the search window in the feature space, which shifts the existing cluster toward the center of the new cluster.

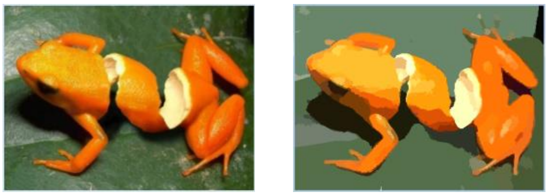
The magnitude and direction of the shift in the feature space based on the difference center of the cluster and the local average value in the cluster. When the value shifts to small (under threshold), the middle value will be declared as the cluster centroid values, and is said to have converged into a single cluster. This procedure is repeated until all significant groups have extracted [3]. To do the process of Mean Shift Color Segmentations, required original image of the input as given in the process of salient object detection. The main idea of the application of Mean Shift Color Segmentation when the grouping process are [3,10]:

- Cluster is the place where the data points tend to be close together and have adjacent colors.
- Assuming that cluster the sample data from probability distributions are independent and identically distributed, and
- Can find local maxima in the probability distribution and the value contained in each cluster.

And two stages repeated until the results of the cluster become stable are:

1. Perform application of mean shift to a pixel representation, which has the most number of colors, and clustered fairly tight, and also has a local minimum, to find a balance, color and distance positions, with several different pixel in determining the changes position of the centroid in the same color.
2. By applying k-means for local minima, which are so much becomes the segment, but it's better than clustered in pixel representation, so the pixel which has a segment with the greatest amount will be set as the centroid of local minima.

By applying these two steps for each iteration in Fig 7.a, the Mean Shift Color Segmentation results obtained will be as in Fig 7.b, And by using the results of the Mean Shift Color Segmentation, will be performed linkage analysis of color, based on the circumference of chain code with the surrounding color region.



a b

Fig 7. Mean Shift Color Segmentation Result Sample.

B. Chain code Detection

In the chain code detection process, taking the value of chain code is done by using the results image from Salient Object Detection called Saliency Region [8]. A chain code detection process which performed by using a modified Freeman chain code concept with the concept Haswadi Hasan et.al. [13], Haswadi Hasan develops new writing techniques, chain code showing the new chain code scheme and algorithms to extract chain code with some intersections which marked with the letter. But in this detection process, the number of intersections which were found will be very much, then writing chain code for intersections that use letters replaced with sequential numbers written in brackets. The process is done by generating every point on edge detection results into a series of separate chain code. The rules setting stays with Freeman's, but can be traced from various directions. The sample chain code writing according to [13] shown in Table 1.

Table 1. Conversion of Haswadi Hasan Chain code Model

Haswadi Hasan [13]	Writing changes
A00B063BA60C	(1)00(2)063(2)(1)60(3)
A11BA556C6667D	(1)11(2) (1)556(3)6667(4)

C. Analyze Color Around Chain Code (Optimization Process)

The most important stages in the optimization process are the stages of color analysis for each region that surrounds chain code. At this stage, the calculation of the equation (1) for each region contained around chain code by using the following calculation and the movements can be seen in Fig 8. The calculation of the equation (1) is done as long as there is a change in the region. For the results of the calculations performed every phase can be seen in Fig 9. And the end result calculation obtained in Fig 10.

$$S'(r) = S(r) + R(c) * f(R(cl), R(cr)) \quad (1)$$

Where :

r	= Number of salient region
c	= Number of chain code element
S'(r)	= The result of optimization saliency region.
S(r)	= Saliency region, of the Salient Object Detection Algorithm.
R(c)	= Regions around the main chain code.
R(cl)	= Regions where are on the left side of the examined chain code.
R(cr)	= Regions where are on the right side of the examined chain code.
f(R(cl), R(cr))	= Function for comparison of the color values of R (cl) and R (cr).

V. Result & Discussion

In this section displayed some of the results obtained by using some of the salient object detection method that is being developed at this time. Since the implementation of Optimized Saliency Region (OSR) is done in multiple images as shown in Fig 11, To view the results of the improvements made, the author conducted 100 tests with the same data used by the testing [8] and [2] that is Weizmann Segmenting Database (THUS10000) and Berkeley Database.

From the comparison of these methods, we show that the optimization process is progressing well on the salient object detection method, the change in salient areas, by prioritizing the object area can be shown on the application of optimization methods, as shown in Fig 12 which contained the amount of deformation saliency cut, while the method of [9] which shown small changes. By using 100 images of salient objects, which has the object area that does not include salient area, this optimization is able to fix 83% of these objects. And for 17% rest, cannot be optimized due to the influence of color on the object which very close to the background, so that the whole area considered as the image background or object.

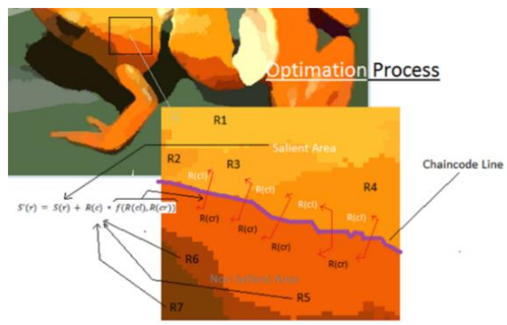


Fig 8. Calculation of Optimization Process.

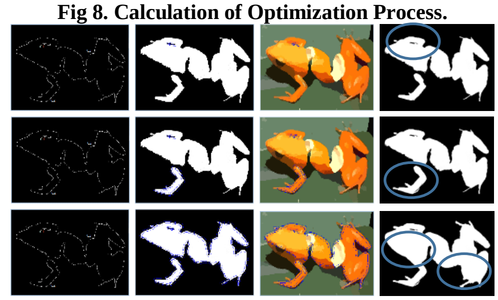


Fig 9. Results of Optimization Process per Stages (from above, Iteration 1, 2, and 3)

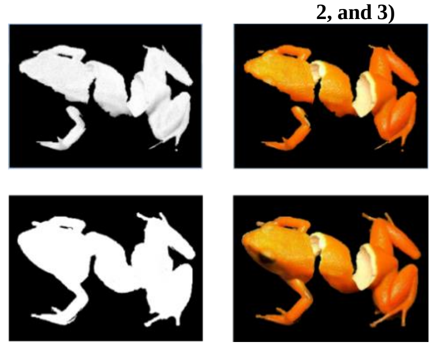


Fig 10. The Results Difference Between Before Optimization (Top) and After Optimization (Below)

VI. CONCLUSION

Optimization of Salient Object Detection by using the effect of color, through Mean Shift Color Segmentation has been successfully performed, the results can show that the optimization results better than the original results of the Salient Object Detection, it's evidenced by the improvements that reached 83% of the objects which use in the test, and has been able to overcome the presence of the object area that does not include salient area. And based on the results of the comparison in the test, we can conclude that, the results obtained by using the Salient Object Optimization are able to increase the yield of salient area becomes more natural Saliency Cut.

For further work on this method, where there are still some weaknesses, such as if the colors are too similar deal between the background and the object or influenced the lighting is not good between salient area with not salient area, it would require a special treatment that is able to overcome these problems, such as the reduce the threshold comparison of the color or add color combinations equality comparisons, and so on. In addition, the error of the results of the saliency detection method itself, would also have an impact on the final result of the optimization process.

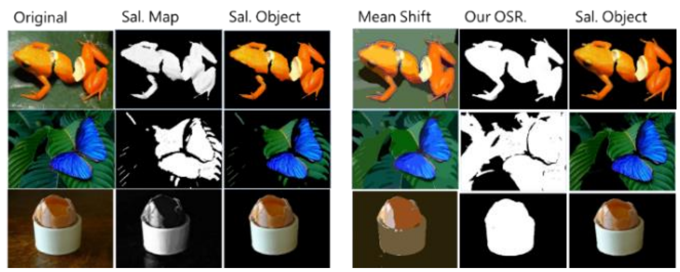


Fig 11. Example results of implementation on several images.

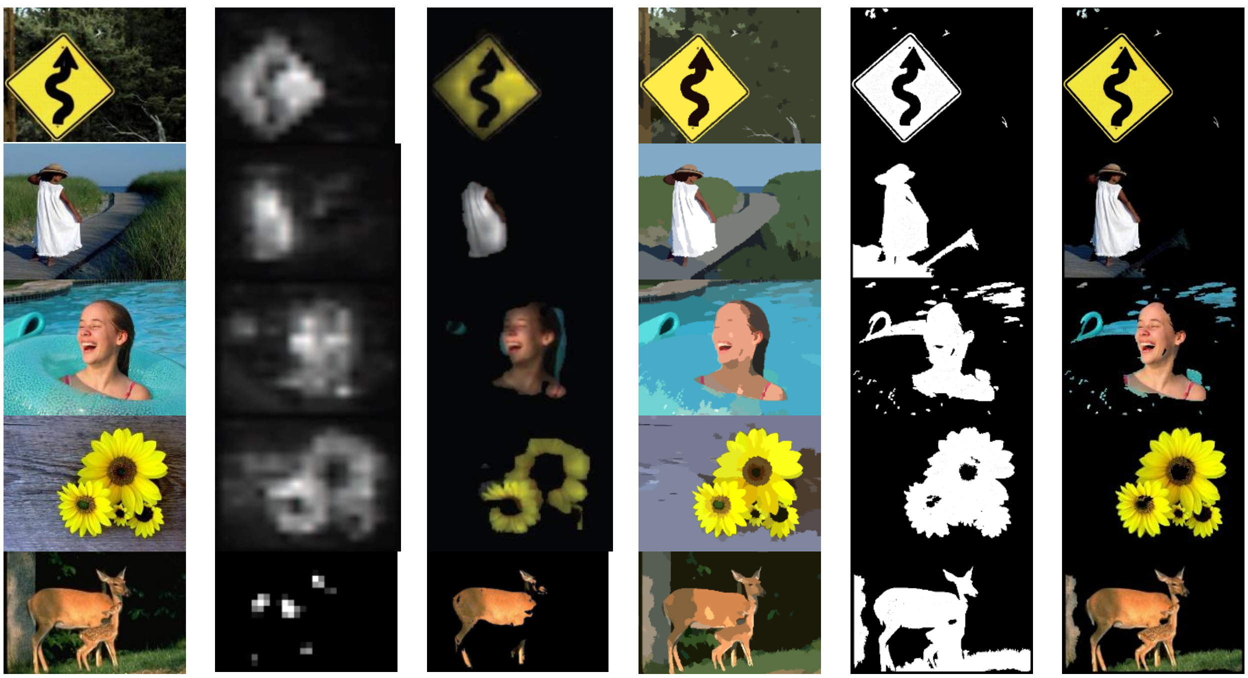


Fig 12. Dari Kiri Ke Kanan : Original Image, Itti Saliency Map (Itti et al., 1998), Itti Saliency Cut, Mean Shift (D. Comaniciu and Meer, 2002), Optimized Saliency Cut, Saliency Images

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